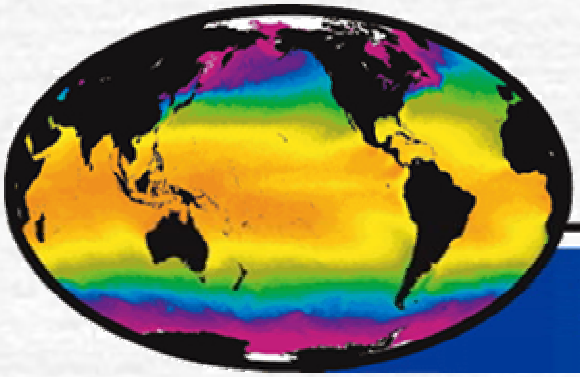


GHRSST-PP

GODAE High Resolution Sea Surface Temperature Pilot Project

Craig Donlon

Presented at the Seventh International GODAE Steering Team meeting (IGST-VII), EUMETSAT, Darmstadt, Germany, February 17th 2002.

GHRSST-PP Home Page http://www.ghrsst-pp.org

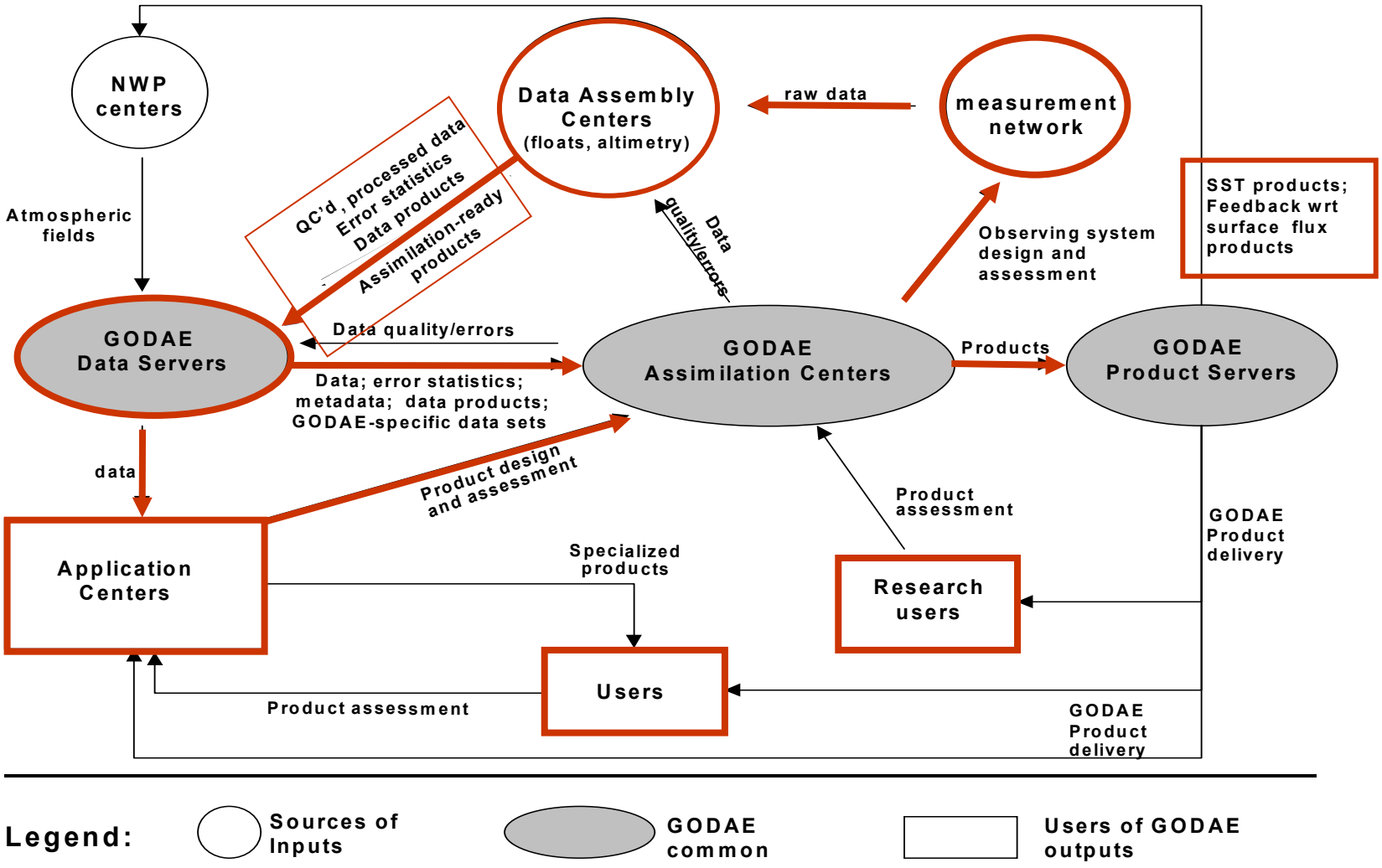
Overview

- Summary of the GHRSST-PP
- Developments since IGST-VI: New sensors, Workshops, ideas and documents
- Implementation of the GHRSST-PP Strategy: Turning the vision into reality
- ISDI-Data processing model: Making sense of it all
- Status of regional projects and funding
- Summary and conclusions

GHRSST-PP Summary (1/5)

- GODAE requires global high-resolution sea surface temperature in near real-time for assimilation into ocean models.
- Major issues are the errors relating to uncertainty in:
  - Atmospheric transmission models
    - not covered as we are dealing with L2 data sets
  - Cloud contamination in IR data sets
  - Atmospheric aerosol contamination
  - Sea Ice extent and SST in the marginal ice zone
  - Aliasing of diurnal variation
  - Instrument stability and calibration
  - and the interpretation of in situ SST relative to the skin and sub-skin measurements provided by satellites.

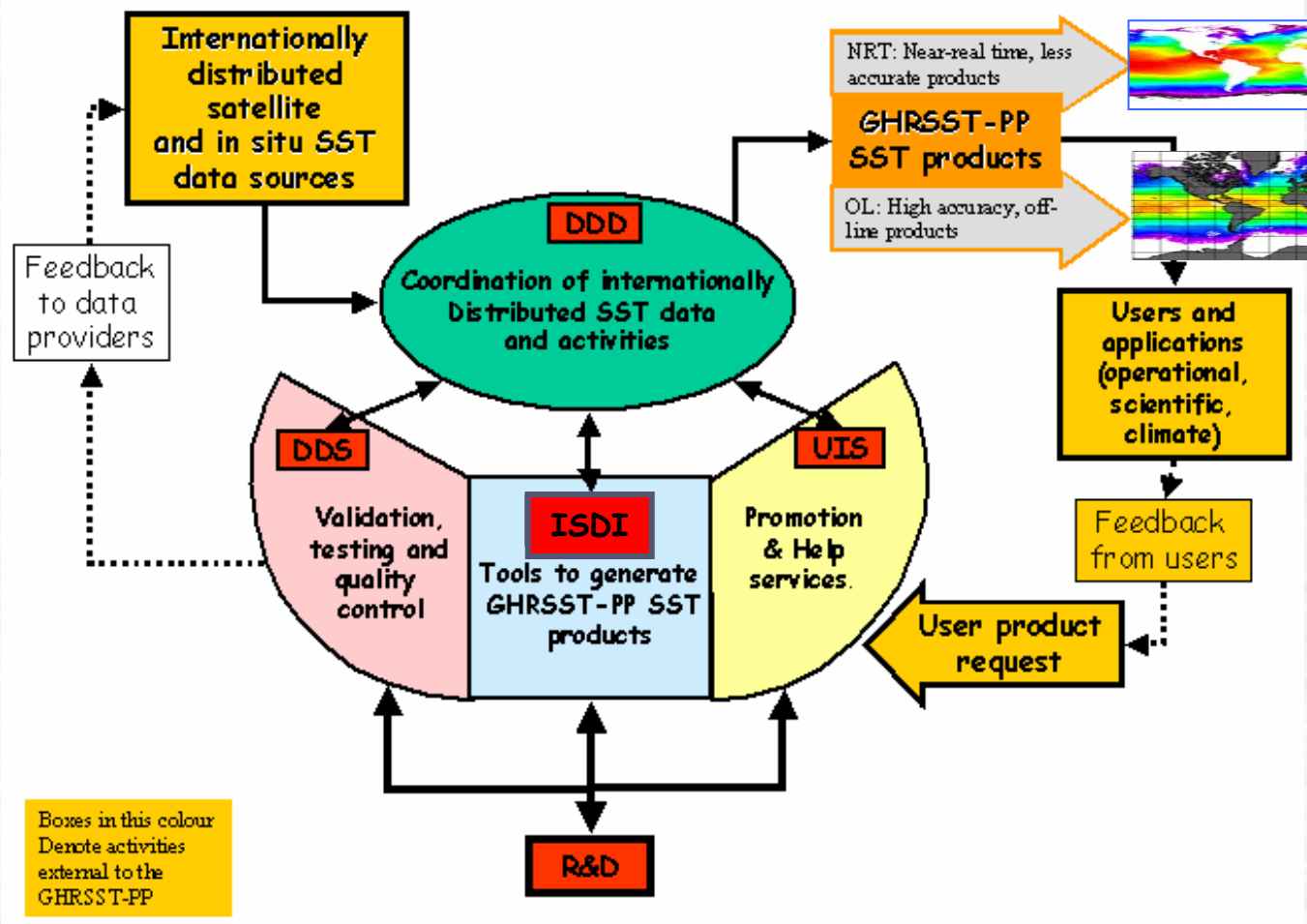
GHRSST-PP Summary (2/5)



Summary (3/5): GHRSST-PP Strategic themes

- **Theme I:** Specification and delivery mechanism of SST products required by different users and diverse applications.
- **Theme II:** Characterisation and identification of differences between SST fields derived from existing satellite and in situ data sources.
- **Theme III:** Targeted research and development for SST data integration.
- **Theme IV:** Generation of new improved, multi-sensor, SST products through integration and assimilation.

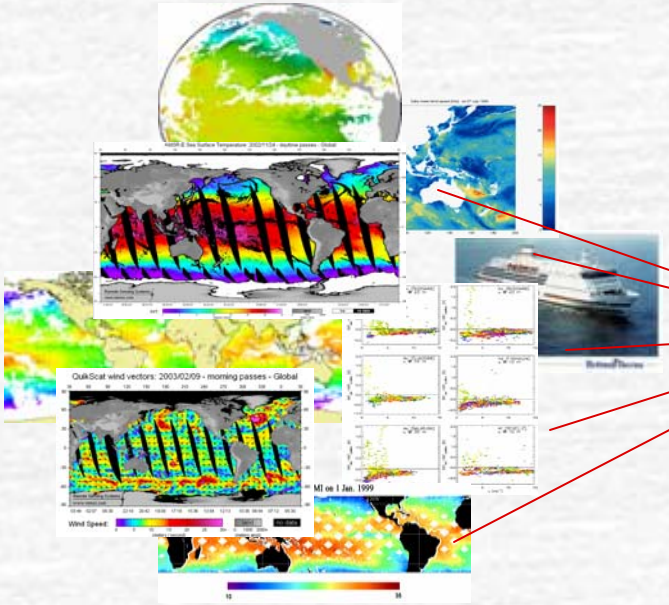
Summary (4/5): The GHRSST-PP Thematic strategy



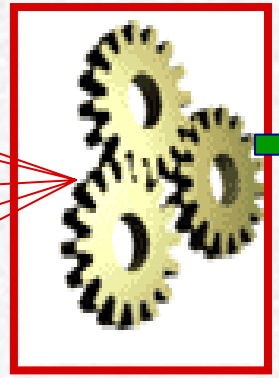
Taken from the GHRSST-PP Strategy and Initial Development Plan (see http://www.ghrsst-pp.org)

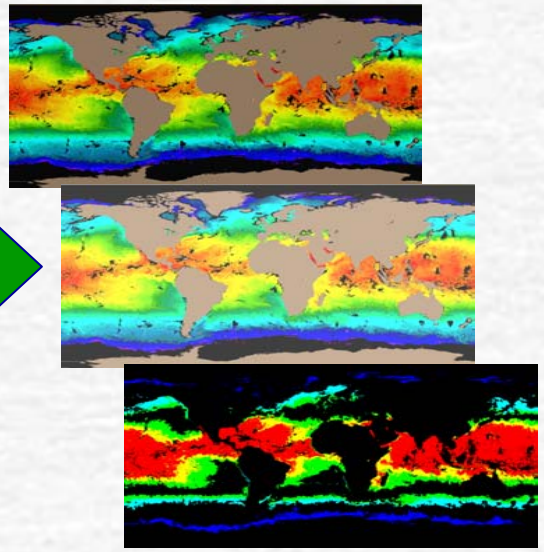
The GHRSST-PP Concept

- In principle, the merging and analysis of complementary satellite and in situ measurements can deliver SST products with enhanced accuracy, spatial and temporal coverage.
- Emphasis on synergy benefits



Quality Control





Move incomplete and inhomogeneous data

Complete, homogeneous QC data and applications

Summary (5/5): Expected GHRSST-PP Outcomes

- Provide a new generation of operational SST products
  - Address the needs of national and international projects (GODAE, GOOS, WOCE, CLIVAR, MERCATOR etc.)
- Ensure that duplication of SST activities are minimized
  - Synchronization of data merging/processing procedures, techniques, algorithms and data formats,
- An operationally efficient methodology for real time fusion of SST data
  - Increased efficiency and cost-effectiveness of SST product generation and delivery
- Develop and foster considerable scientific and operational knowledge during the lifecycle of the GHRSST-PP
  - Increase the network capacity within international and national projects of differing scope and budget

Summary of GHRSST-PP at IGST-VI

- Initial GODAE workshop, JRC, Ispra, Italy Nov. 2000
  - Based on a GODAE SST prospectus document
  - Established the GHRSST-PP and Science Team
  - Developed a Strategy document (IGST-VI report)
  - Proposed 2nd workshop in Tokyo

Developments since IGST-VI:

New sensors, Workshops, ideas and documents

GHRSST-PP: major events (1/2)

- Second Workshop, NASDA EORC, Tokyo, May 2002
  - Established the basis for a GHRSST-PP implementation plan
  - Established an In situ and Satellite Data Integration (ISDI) TAG
  - Established Reanalysis project (RAN)
- Interim:
  - Outline of ISDI-Processing Model (ISDI-PM), liaison with users
  - Established GHRSST-PP web site
  - Published recommendations of the ISDI-TAG
  - Developed a HR-DDS technical implementation reference
  - Developed a European implementation project: Medspiration with ESA

GHRSST-PP: major events (2/2)

- Developed a NOPP submission for SST validation with U. Miami
- Submitted a proposal to NASA ReASON for USA support
- 4 major satellite platforms successfully launched
- First formal dialog with user community: input and requests
- Currently working on an ISDI-Processing Model v1 and the GHRSST-PP Development and Implementation Plan (GDIP)
- Shortly to establish an International Project Office with ESA support at the Met Office UK (Ocean Modelling, Hadley Centre, NWP Satellite Applications)
- ESA AATSR data server proposal accepted
- NASDA GHRSST-PP SST data server underway
- Some headway with MODIS
- Third Workshop, ESA/ESRIN Frascati, Italy, December 2002

GHRSST-PP Science Team

- Hiroshi Kawamura
- Bill Emery
- Ian Robinson
- Chelle Gentemann
- Chris Mutlow
- Doug May
- Gary Wick
- Ian Barton
- Jim Cummings
- Neville Smith
- Nick Rayner
- Peter Minnett
- Bob Evans
- Pierre LeBorgne
- Craig Donlon (chair)
- Dick Reynolds
- Andy Harris
- Ed Armstrong
- Ken Casey
- Jorge Vasquez

GHRSST-PP organization

GCOS International GODAE Steering Team (IGST)

International GHRSST-PP Project Office (Sept. 2003)

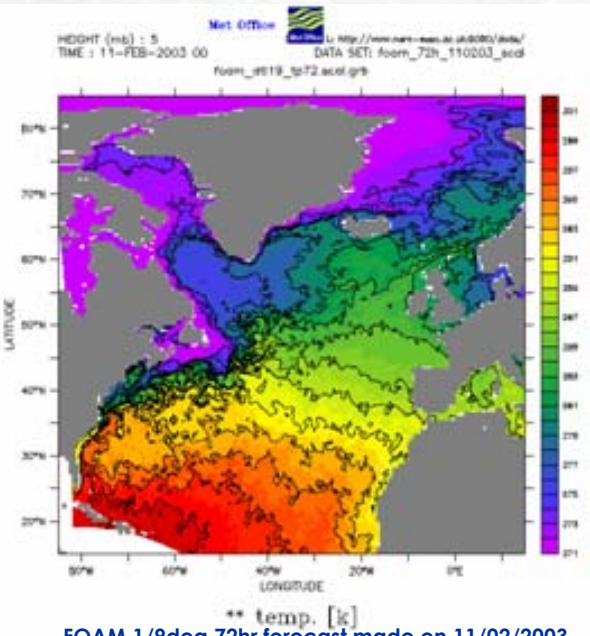
International Science Team

GHRSST-PP Reanalysis Project coordinating group (RAN-CG)	In Situ and Satellite Data Integration Technical Advisory Group (ISDI-TAG	GHRSST-PP Data management coordinating group (DM-CG)

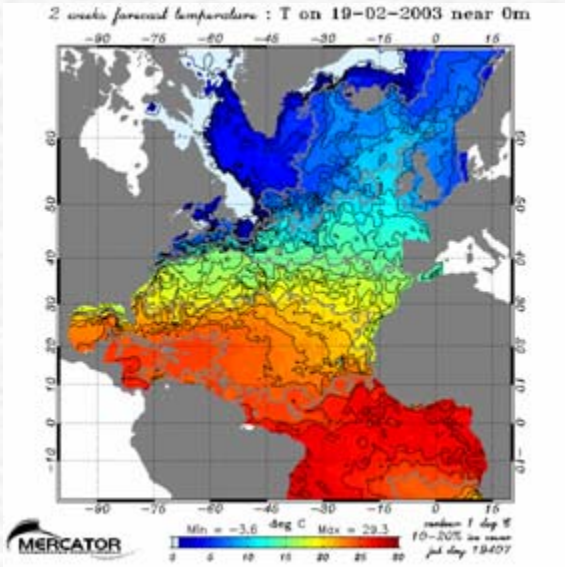
GHRSST-PP Partners

Users requesting GHRSST-PP data products (3rd Workshop)

MERCATOR http://www.mercator.com.fr
ECMWF : Impact on MRWF study http://www.ecmwf.int
ECMWF : Impact on Seasonal Forecast study http://www.ecmwf.int
FOAM (global) http://www.met-office.gov.uk/sec5/OA/FOAM/FOAM.html
FOAM (regional) http://www.met-office.gov.uk/sec5/OA/FOAM/FOAM.html
HYCOM http://hycom.rsmas.miami.edu/
FNMOC http://www.fnmoc.navy.mil/
NASA Seasonal-to-Interannual Prediction Project (NSIPP) http://nsipp.gsfc.nasa.gov
NRL/NAVOCEANO NLOM http://www7320.nrlssc.navy.mil/global_nlom/ http://www.navo.navy.mil/
JMA/OMP/MRI COMPASS-K http://www.mri-jma.go.jp/Dep/oc/modeln.html
JAMSTEC and Kyoto University: FORSGC1&2 http://www.jamstec.go.jp/frsgc/jp/news/no16/eng/pgm02.html
ECCO Consortium http://www.ecco.ucsd.edu
CLIVAR http://www.clivar.org
GMES/MERSEA-IP http://www.cls.fr/html/oceano/general/applications/welcome_en.html
Norwegian Meteorological Office (DNMI) http://projects.dnmi.no/~saf/



FOAM 1/9deg 72hr forecast made on 11/02/2003



MERCATOR bi-weekly forecast made on 5/02/2002

Norwegian Meteorological Institute met.no

Met Office

EuroGOOS

http://www.ghrsst-pp.org

GHRSST-PP

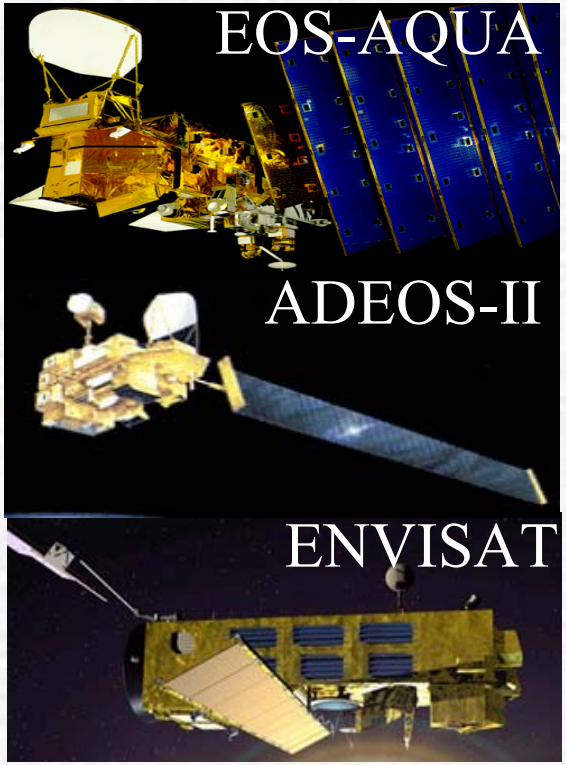
SST from new Satellite systems

- MW: AMSR-E
- IR: MODIS, AIRS

- MW: AMSR
- IR: GLI

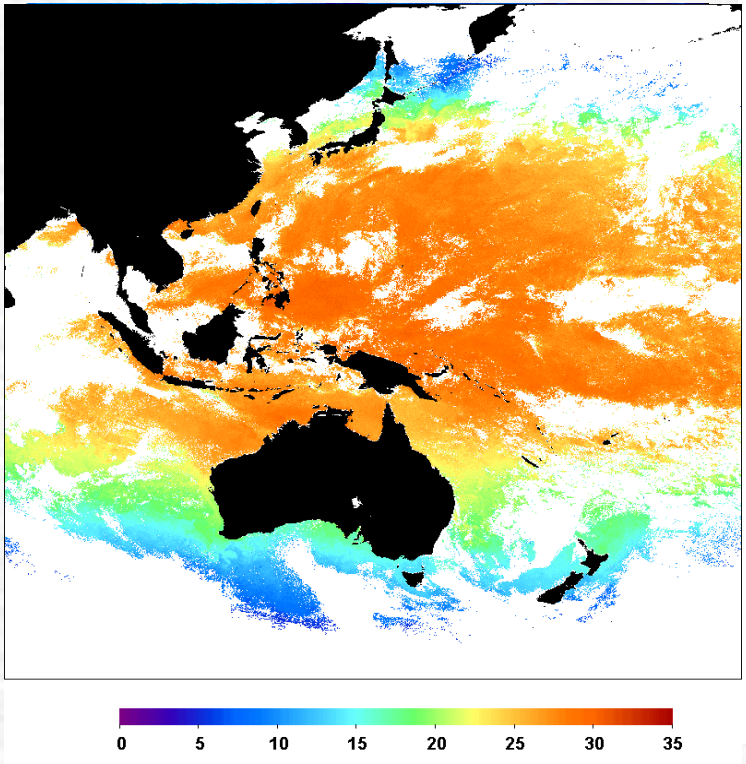
- IR: AATSR

- IR:MSG SEVIRI

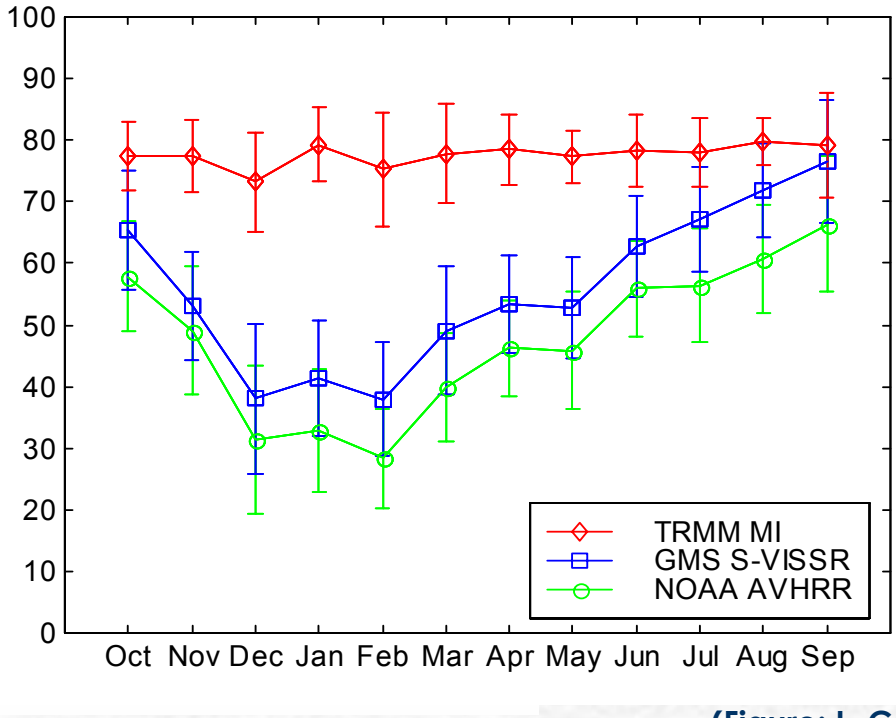


SEVIRI 12um
(EUMETSAT)

IR sensors: optimal spatial and radiometric resolution



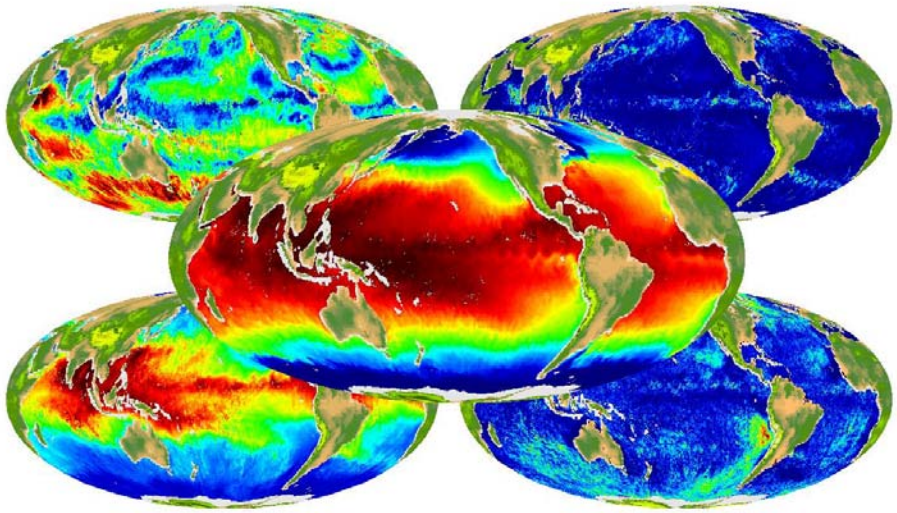
GMS VISSR SST Japan (H. Kawamura)



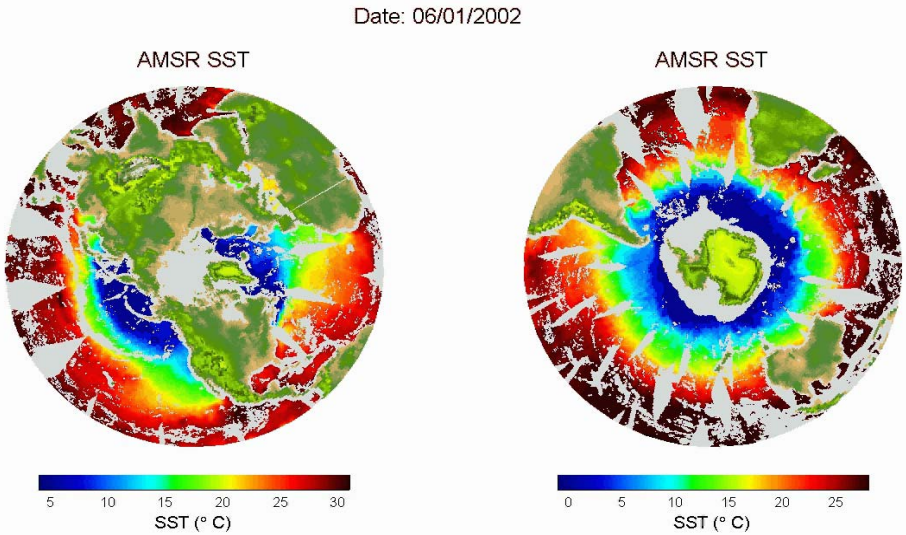
(Figure: L. Guan)

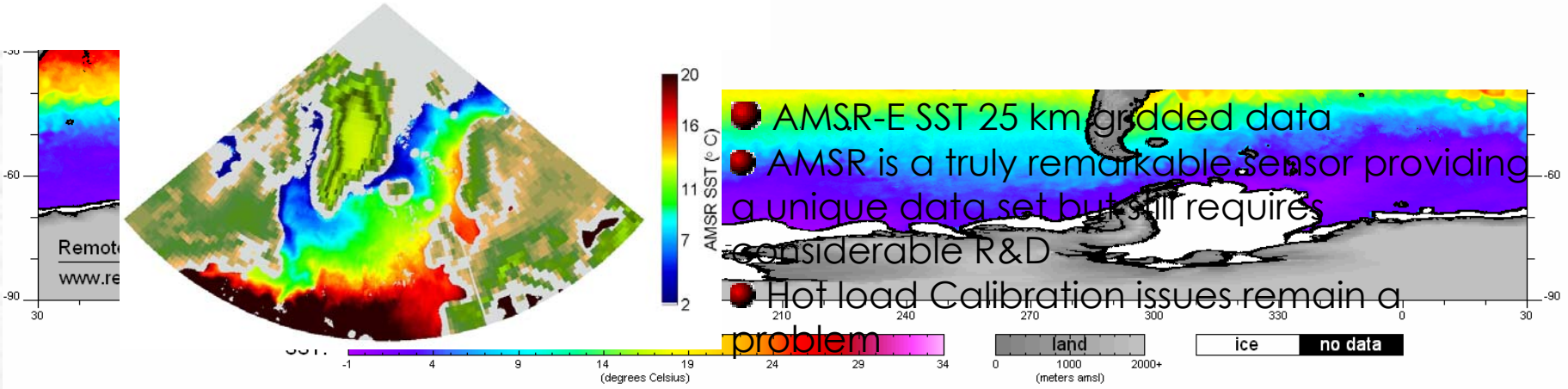
- High radiometric accuracy and fidelity (L. Horrocks)
- Daily global coverage (AVHRR, MODIS) and high regional temporal coverage (e.g., MSG SEVIRI, GMS, GOES, Meteosat)
- But a major problem with cloud
  - Persistent in particular regions and seasons
  - e.g., GMS footprint over Japan RDAC area

A revolution: AMSR-E and AMSR SST



AMSR SST Date: 07/17/2002





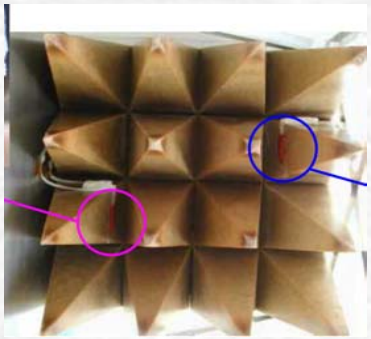
- AMSR-E SST 25 km gridded data
- AMSR is a truly remarkable sensor providing a unique data set but still requires considerable R&D
- Hot load Calibration issues remain a problem

GHRSST-PP

AMSR-E Hot load Calibration problems

(C. Gentemann, 3rd Workshop)

AMSR-E Hot Load

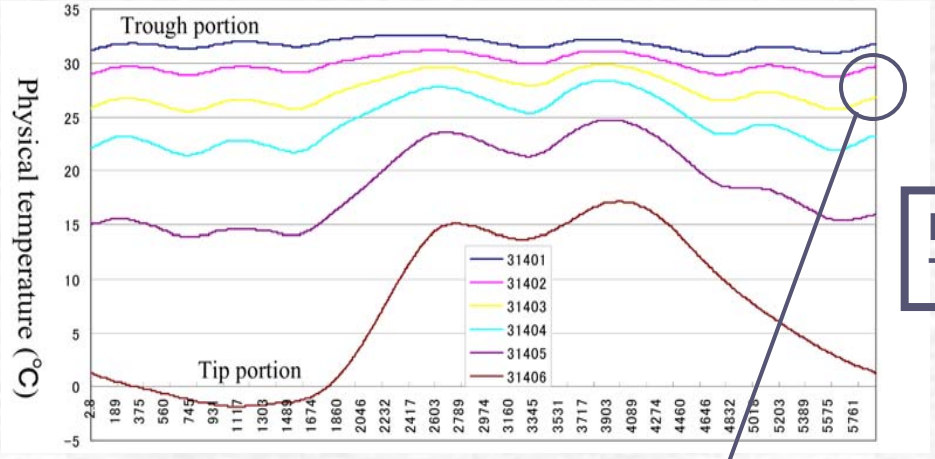


8 thermistors
16 heaters on 4 different circuits

308 K

298 K

273 K

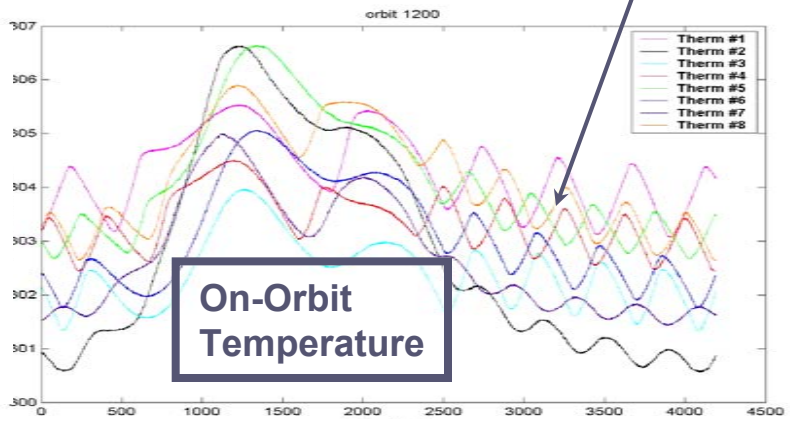


Predicted Temperature

Eq S.P. Eq. N.P. Eq.

307 K

300 K



On-Orbit Temperature

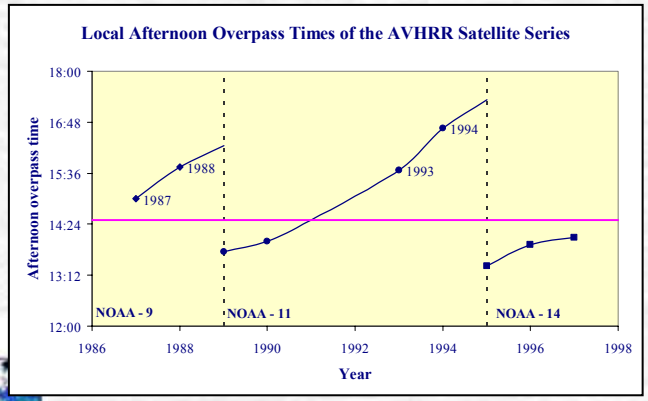
S.P. Eq. N.P. Eq. SP

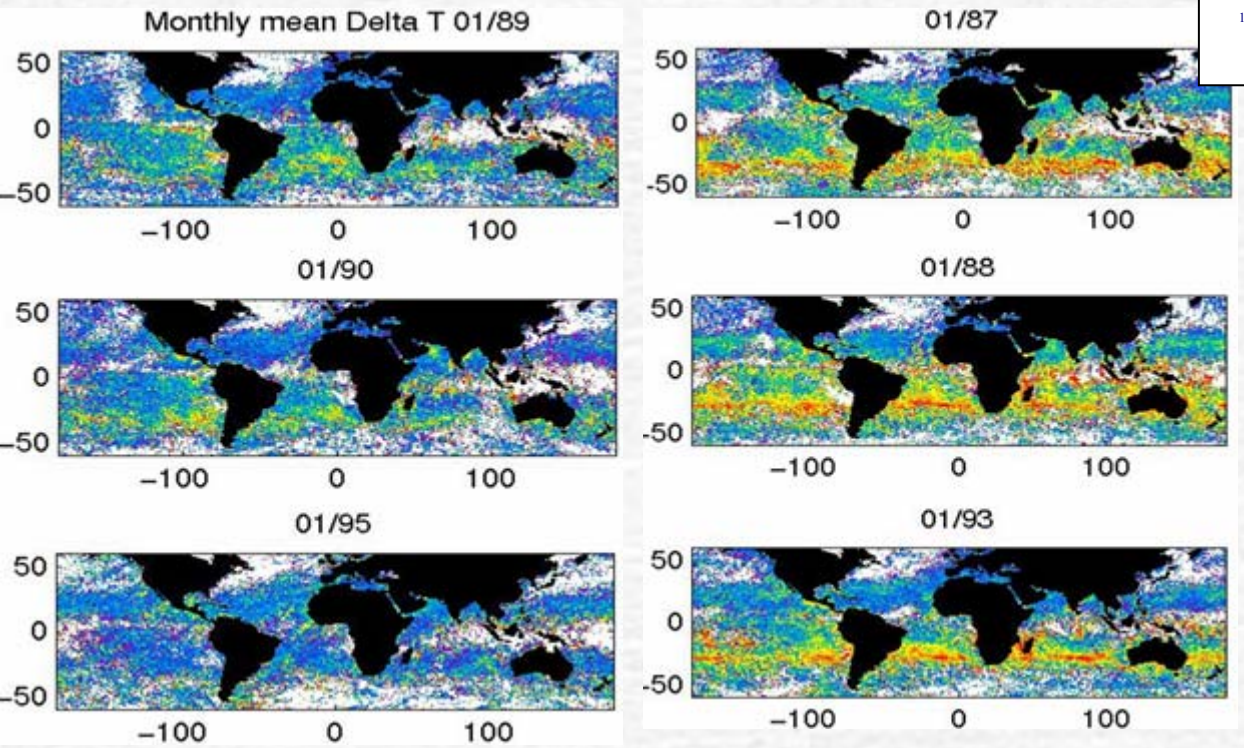
GHRSST-PP

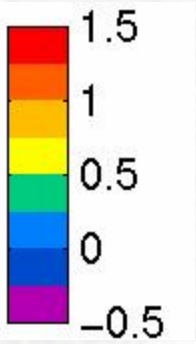
Diurnal sampling bias

(GHRSST 3rd Workshop A. Stuart-Menteth)

Polar-orbiting sensors: AVHRR where the local time of the satellite overpass drifts over the afternoon. Observed diurnal warming impacts interannual biases



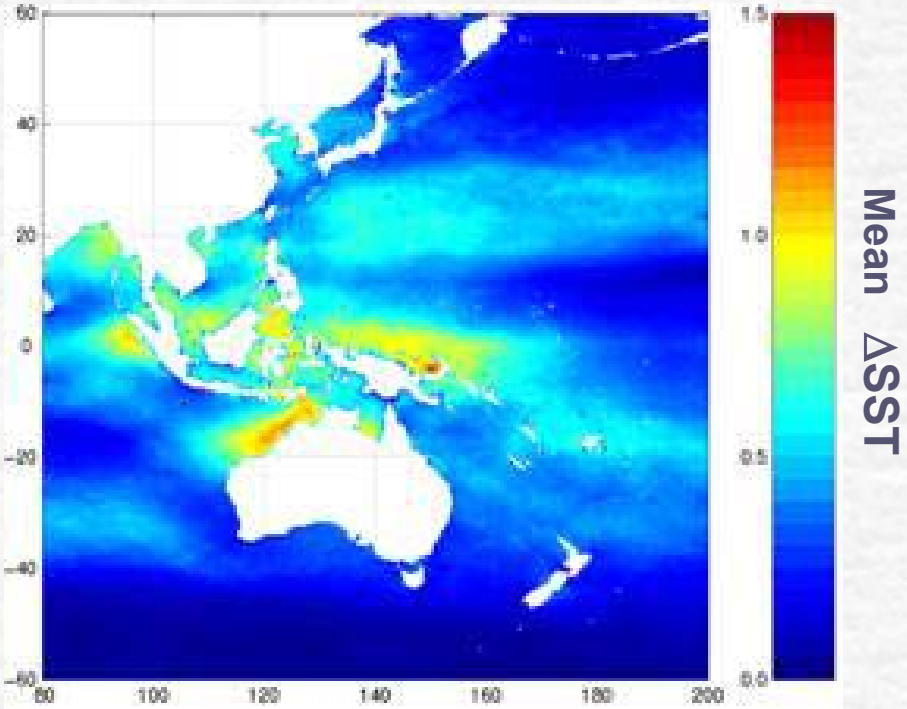




GHRSST-PP

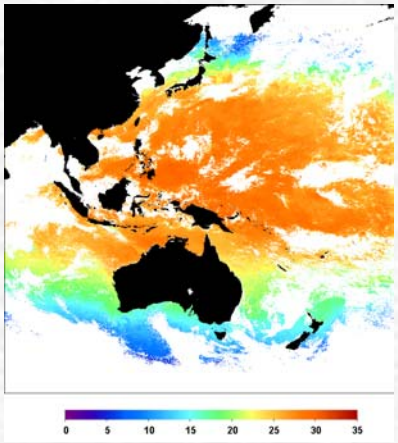
Annual mean diurnal signals

- Annual mean of diurnal warming over the GHRSST-PP Japanese RDAC area (GMS footprint)
- Based on SSI, wind speed and 1D model (Kawai and Kawamura 2002)

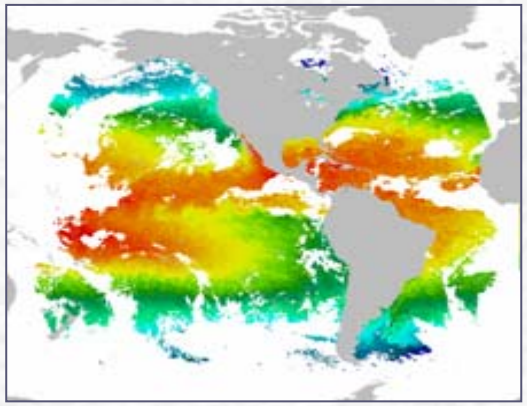


(Figure: H. Kawamura)

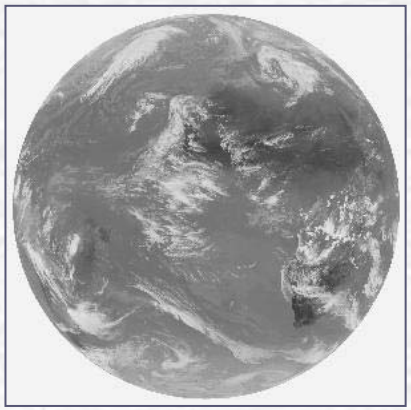
Global coverage every hour: SST from Geostationary IR imagers



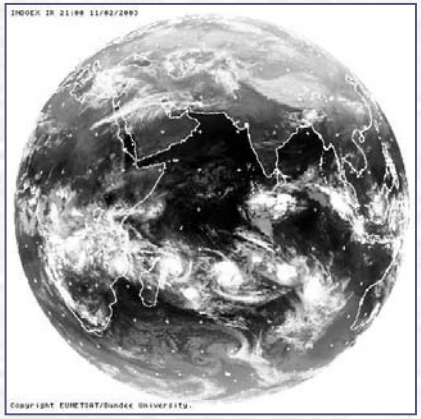
GMS VISSR SST Japan
(H. Kawamura)



GOES-E & W SST
(D. May)



SEVIRI 12um
(EUMETSAT)



Meteosat-5
(U. Dundee)

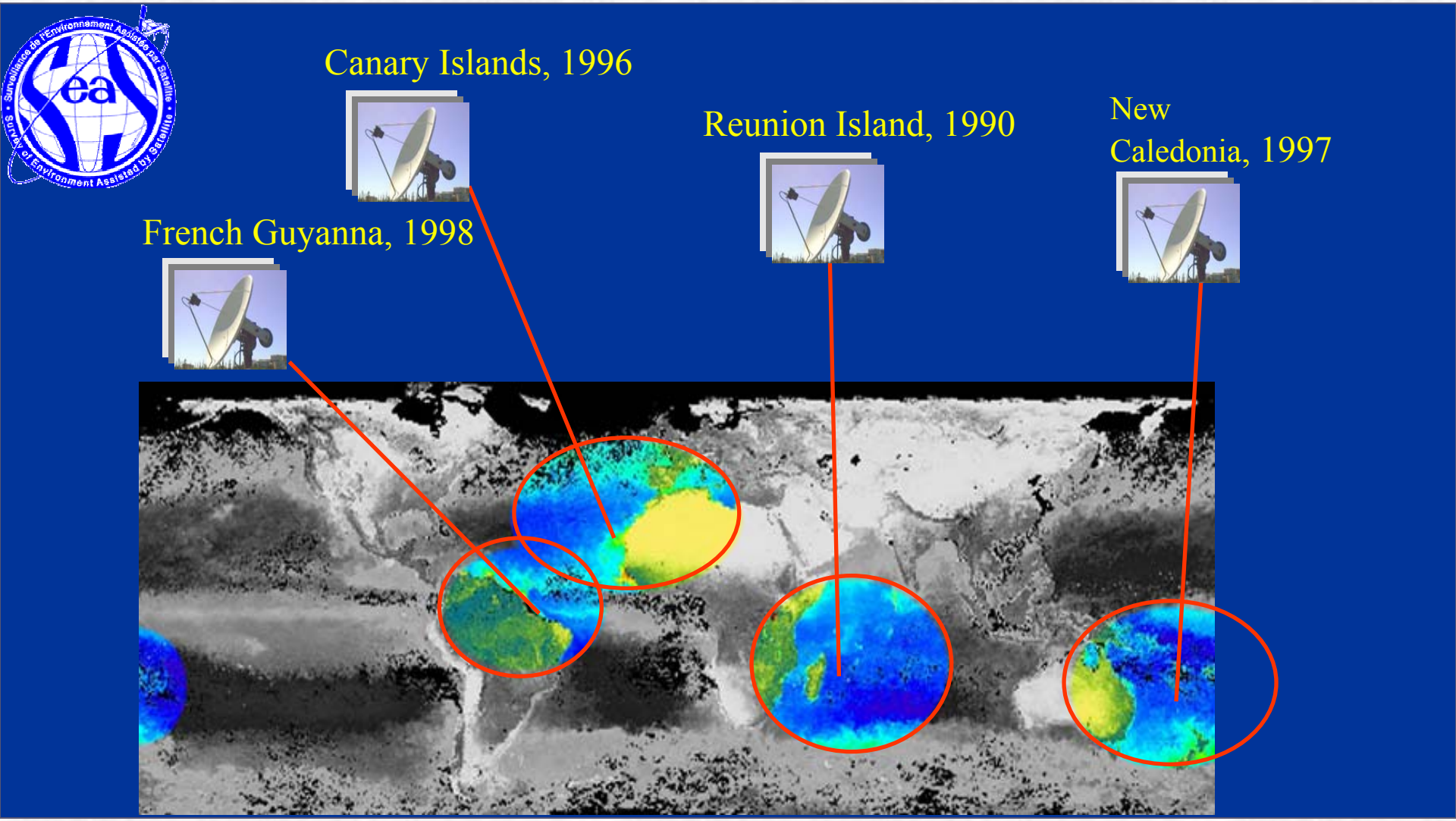
- Coverage every 15 minutes, ~5km spatial resolution
- Data management challenge
- Global coverage but calibration issues remain (Meteosat-5 and future GOES, no split window)
- Infrared imagers – cloud contamination is severe

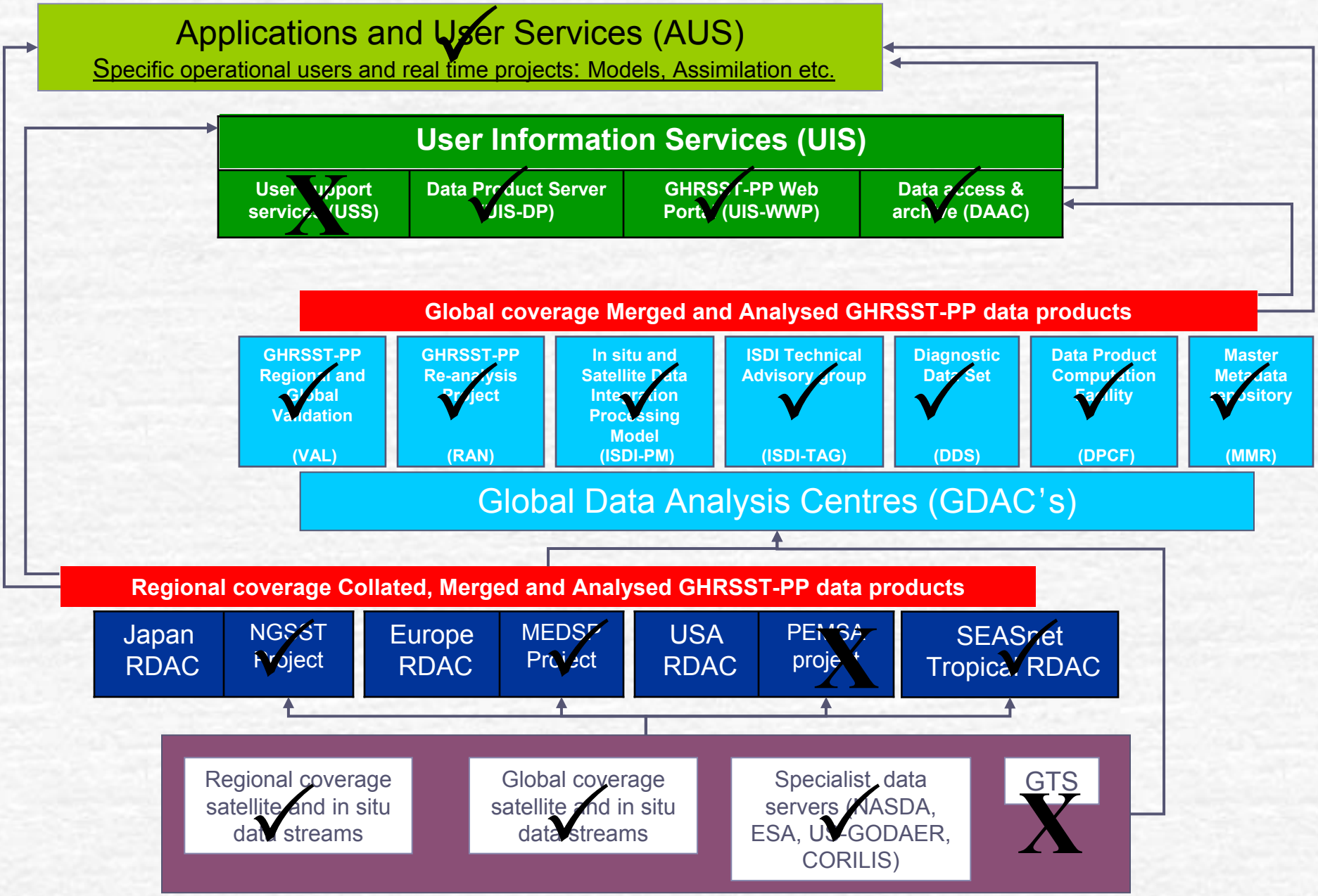
Implementation of the GHRSST-PP Strategy: Turning the vision into reality

Implementation strategy

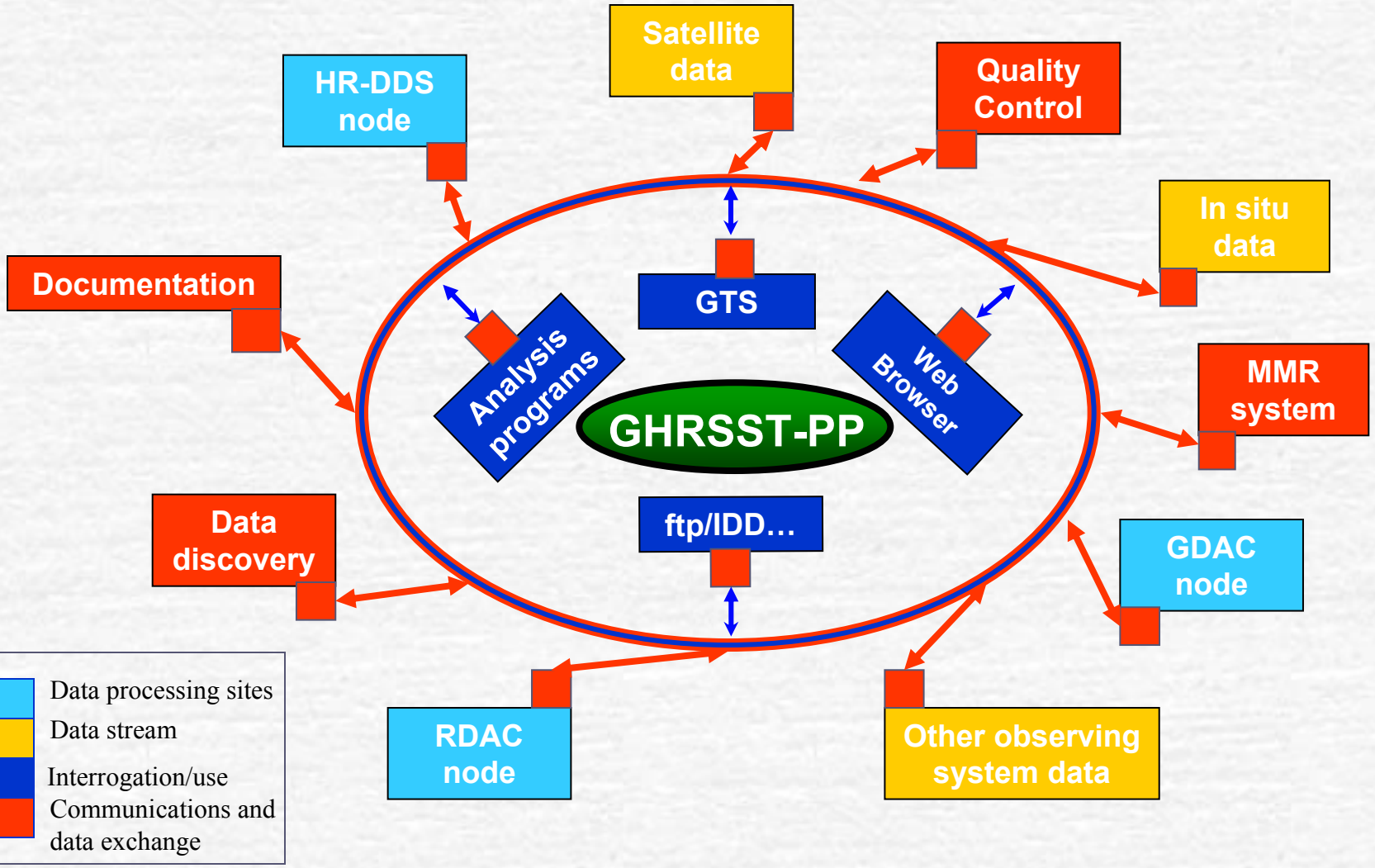
- Implementation needs a framework for success
  - Follow a pragmatic approach
  - Use what is already available
  - Build on existing capacity
- Preserve and enhance regional autonomy and identity
  - Provide a platform for regional actions
  - Preserve regional infrastructure and R&D investments
  - Leverage regional funding
- Provide a global project focus
  - For data products, agencies and scientists
  - Data management; metadata – the unifying project "matrix"
  - Active outreach, promotion,and capacity building
  - Maintain the GODAE identity by working closely with GODAE applications
- Implementation Plan is founded on a Global/Regional task sharing approach

Global/regional task sharing and connectivity




Applications and User Services (AUS)
Specific operational users and real time projects: Models, Assimilation etc.
User Information Services (UIS)
User support service (UUSS)
Data Product Server (UIS-DP)
GHRSST-PP Web Portal (UIS-WWP)
Data access & archive (DAAC)
Global coverage Merged and Analysed GHRSST-PP data products
GHRSST-PP Regional and Global Validation (VAL)
GHRSST-PP Re-analysis Project (RAN)
In situ and Satellite Data Integration Processing Model (ISDI-PM)
ISDI Technical Advisory group (ISDI-TAG)
Diagnostic Data Set (DDS)
Data Product Computation Facility (DPCF)
Master Metadata repository (MMR)
Global Data Analysis Centres (GDAC's)
Regional coverage Collated, Merged and Analysed GHRSST-PP data products
Japan RDAC
NGSST Project
Europe RDAC
MEDSEA Project
USA RDAC
PEMSA project
SEASnet Tropical RDAC
Regional coverage satellite and in situ data streams
Global coverage satellite and in situ data streams
Specialist data servers (NASDA, ESA, US-GODAER, CORILIS)
GTS

Working together as part of the GODAE Data sharing Pilot



UIS & AUS: Users and Applications

- The Applications and User Services (AUS) links the GHRSST-PP to Specific operational users and real time projects in close collaboration with the GHRSST-PP science team.
  - E.g., MERCATOR, FOAM, JMA, CLIVAR, Satellite Flux development etc.
  - Interactive Workshops and targeted outreach initiatives
  - Develop a deep relationship with specific applications to ensure appropriate feedback
- The User Information Service (UIS) provides low volume data access and information on GHRSST-PP logistics and operations
  - Active archive and data access system
  - Access and use of the GHRSST-PP GDAC DPCF
  - Services for GHRSST-PP RDAC, GDAC and data providing agencies/institutions

GHRSST-PP Data management coordinating group

- Challenging aspects of GHRSST-PP.
- A remit to provide input and guidance to the ST on:
  - File formats (netCDF, GRIB, HDF)
  - Conventions (CF, MXML?, DODS/OPeNDAP)
  - Data exchange mechanisms (IDD, sftp, DODS, LAS, etc)
  - Telemetry and transport (timelines to Operations)
  - Metadata Management
  - Data assembly, data set integrity, quality control
  - Data archive (deep and short-term)
  - Applications and user interfaces
- Metadata model, transport, archive and discovery are now in place (v1.0)
- Initial focus on Metadata specification. CF & FGDC compliant, built on the GCMD DIF structure – fully documented in ISDI-PMv1 and HR-DDS implementation plan (draft)
- Work closely with the GODAE DS pilot.

Reanalysis project (RAN)

- Coordinating group has been established. Chair: Ken Casey (NOAA)
  - Discussion now well under way.
  - Emphasis on climate aspects of SST from space
  - Summary report of initial discussions expected soon
- Preparation for reanalysis to begin in 2005 once ISDI-PM is stable and operational
  - Based on L2P/L2C data streams augmented by delayed mode data (MODIS, AIRS, GLI)
  - Stringent requirements set by ECMWF: 0.1K absolute SST on 1° grid.
- RAN-Strategy document expected in mid 2003.
- RAN-implementation plan expected 2004.

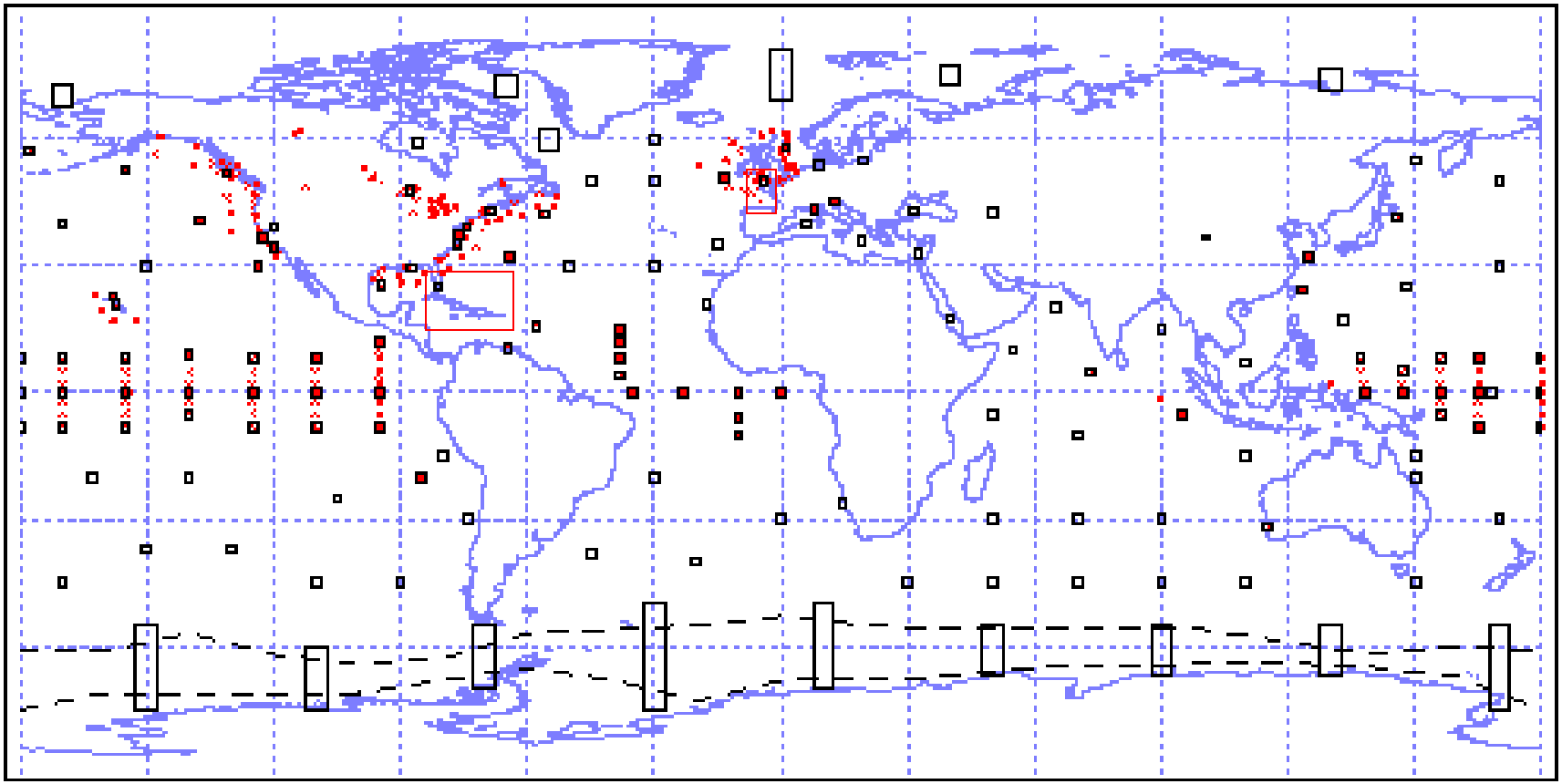
UIS-WWW: www.ghrsst-pp.org

- Web page established at JRC
- Outreach, support and organisation
- Purchased the domain name for .org and .com for 5 years
- Due for revision now (After the 3rd workshop proceedings, GDIP, and ISDI-PM documents !)
- System mirrored at JPL PO.DAAC system
- Japanese mirror to be established soon on Japanese server
- Also linked to NASA GCMD as a Project Portal
- Soon to add DODS capability

The GHRSST-PP High Resolution Diagnostic Data Set (HR-DDS).

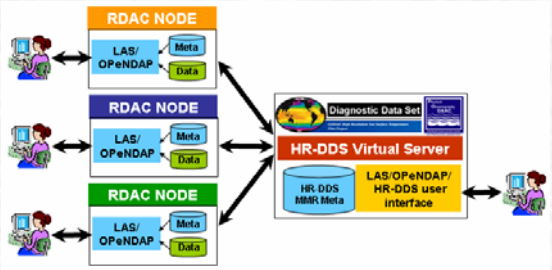
- To develop a manageable data resource and framework for sharing of data to enable pixel data inter-comparison and analysis.
  - Implementation of IGOS measurement principles
  - Critical for operational GHRSST-PP QC
  - Fundamental to GHRSST-PP RAN project
- Published a draft implementation plan (GHRSST/13)
- HR-DDS is the main SST learning tool for GHRSST-PP project scientists
- It must be implemented and populated at the national/regional level as a shared resource for all

HR-DDS-v2.2 locations



- Based on output of the 2nd & 3rd GHRSST-PP workshop Science Team feedback. Fully documented in the HR-DDS Implementation Plan (GHRSST/14)

DDS: Functional diagram of a GHRSST-PP HR-DDS node using OPeNDAP



RDAC L2P, L3C, L3A, L4A, L4DV and model data sets

Local RDAC HR-DDS node

HR-DDS extraction | Data archive | Metadata archive | Metadata repository

OPeNDAP/http/sftp "Middleware"

Web Browser

Analysis programs

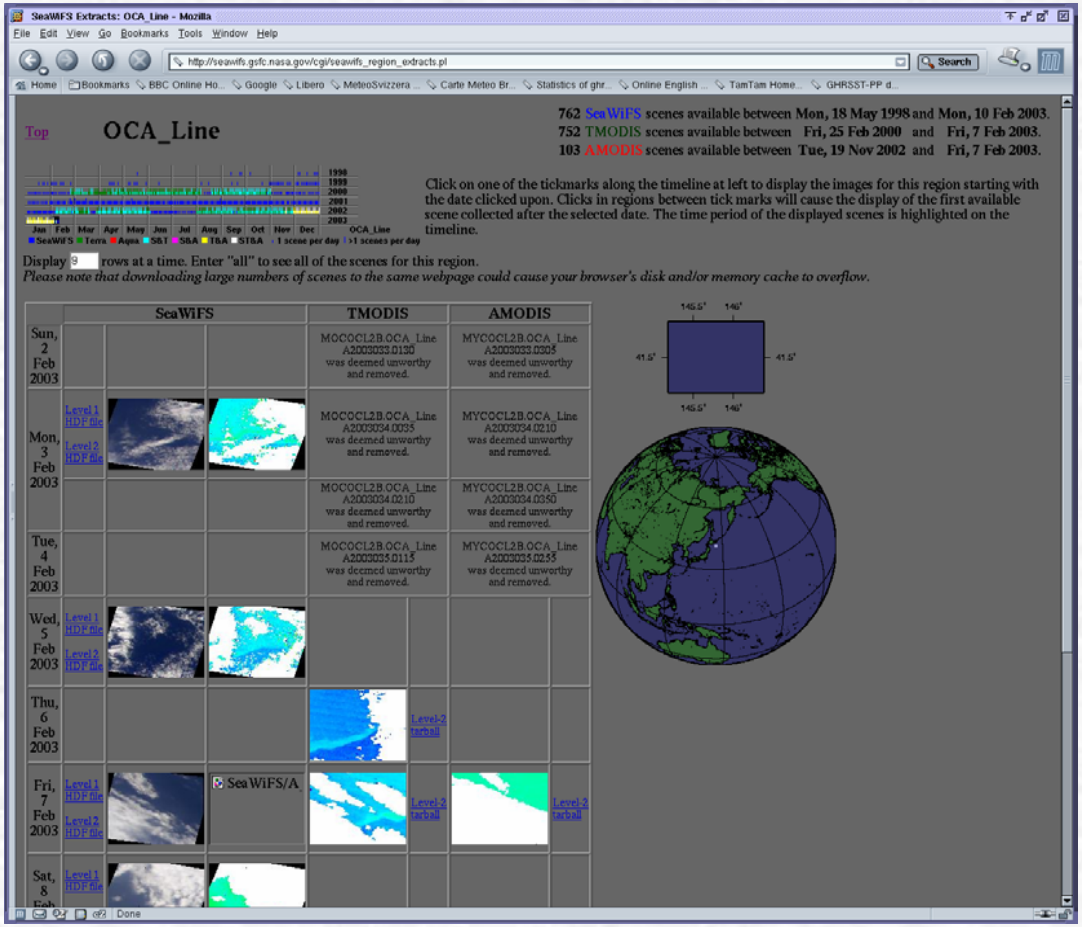
sftp

User interface

Global HR-DDS master metadata repository (MMR)

HR-DDS RDAC node
RDAC data stream
Interrogation/use
Communications and data exchange

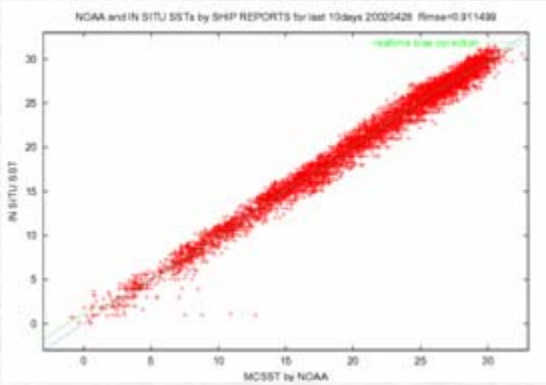
Collaboration with NASA SeaWiFS HR-DDS system



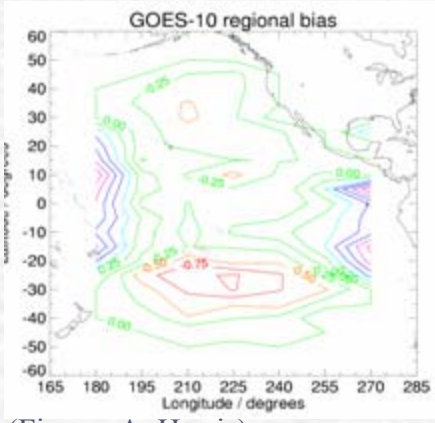
- NASA SeaWiFS DDS system is now in place and active.
- Contact with Gene Feldman: Agrees in principle to the common use of SeaWiFS DDS WWW interface, backend code and data sharing.
- Considerable benefits to GHRSST-PP in terms of Diurnal warming studies and atmospheric aerosol studies

SST bias differences

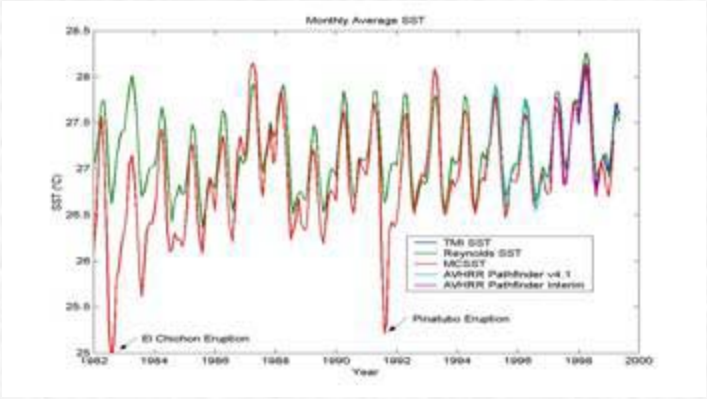
- **In an operational inter-comparison framework, bias differences between complementary SST data streams can be recognised**



(Figure: T. Sakurai)

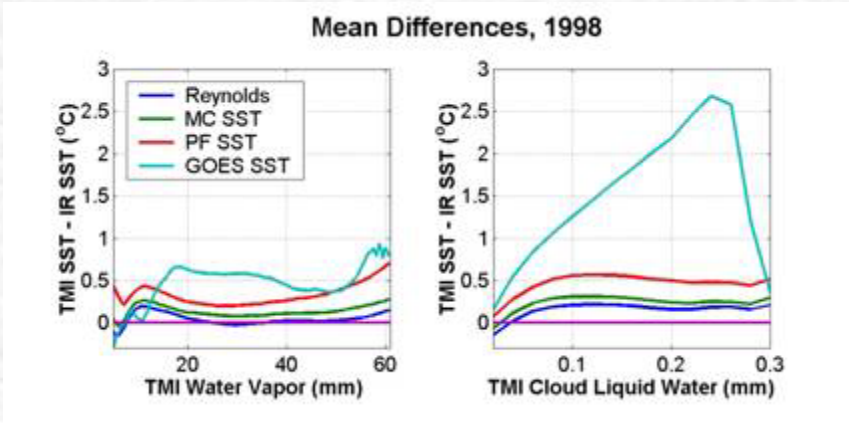


(Figure: A. Harris)



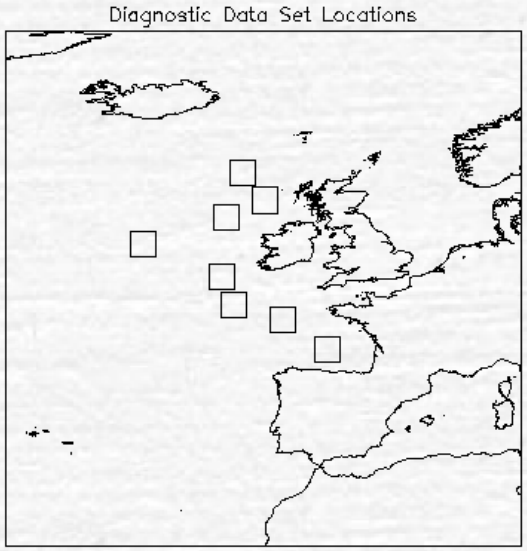
(Figure: C. Gentemann)

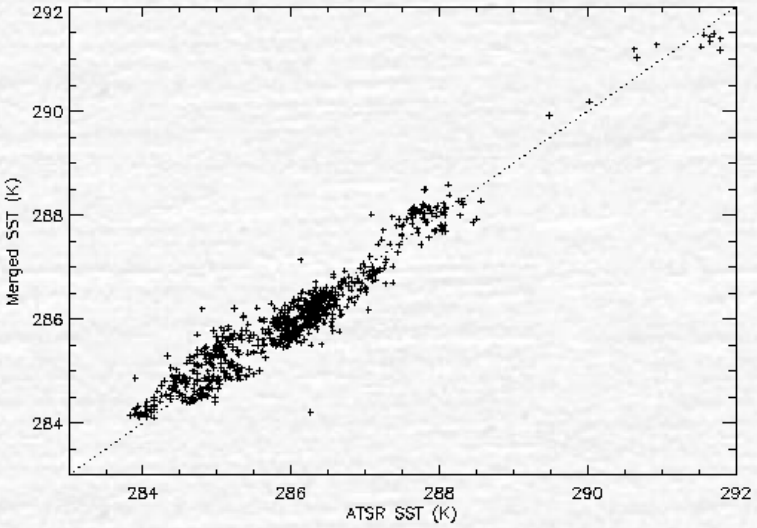
- **GHRSST-PP will address bias by inter-comparison and analysis in real time within the HR-DDS system and via validation experiments**



(Figure: C. Gentemann)

Bias correction of AVHRR using ATSR-2 SST within the HR-DDS: Initial results



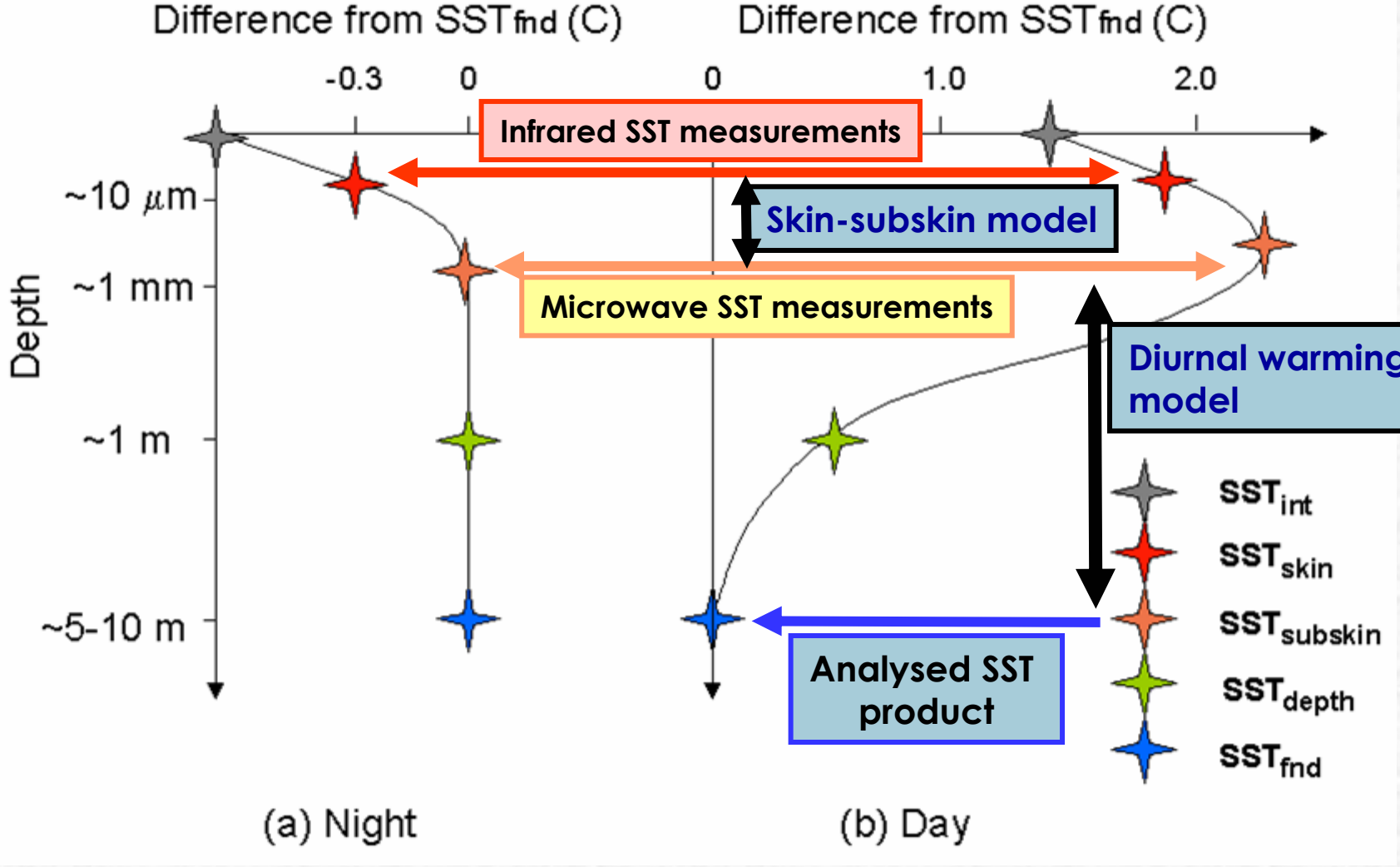


- Prototype HR-DDS using AVHRR GAC, ATSR-2 and TMI data has been developed at the JRC, Italy.
  - Example use Assume ATSR is correct, use local DDS sites placed over EGOS buoys
  - New SST algorithm form based on regression between contemporaneous ATSR-2 ASST and AVHRR:
  - CAASST = 23.08 + 3.0810 T4 - 2.1660 T5 - 0.63280 (T4 - T5)*(sec(vza) - 1) npts 370, rms 0.26 K

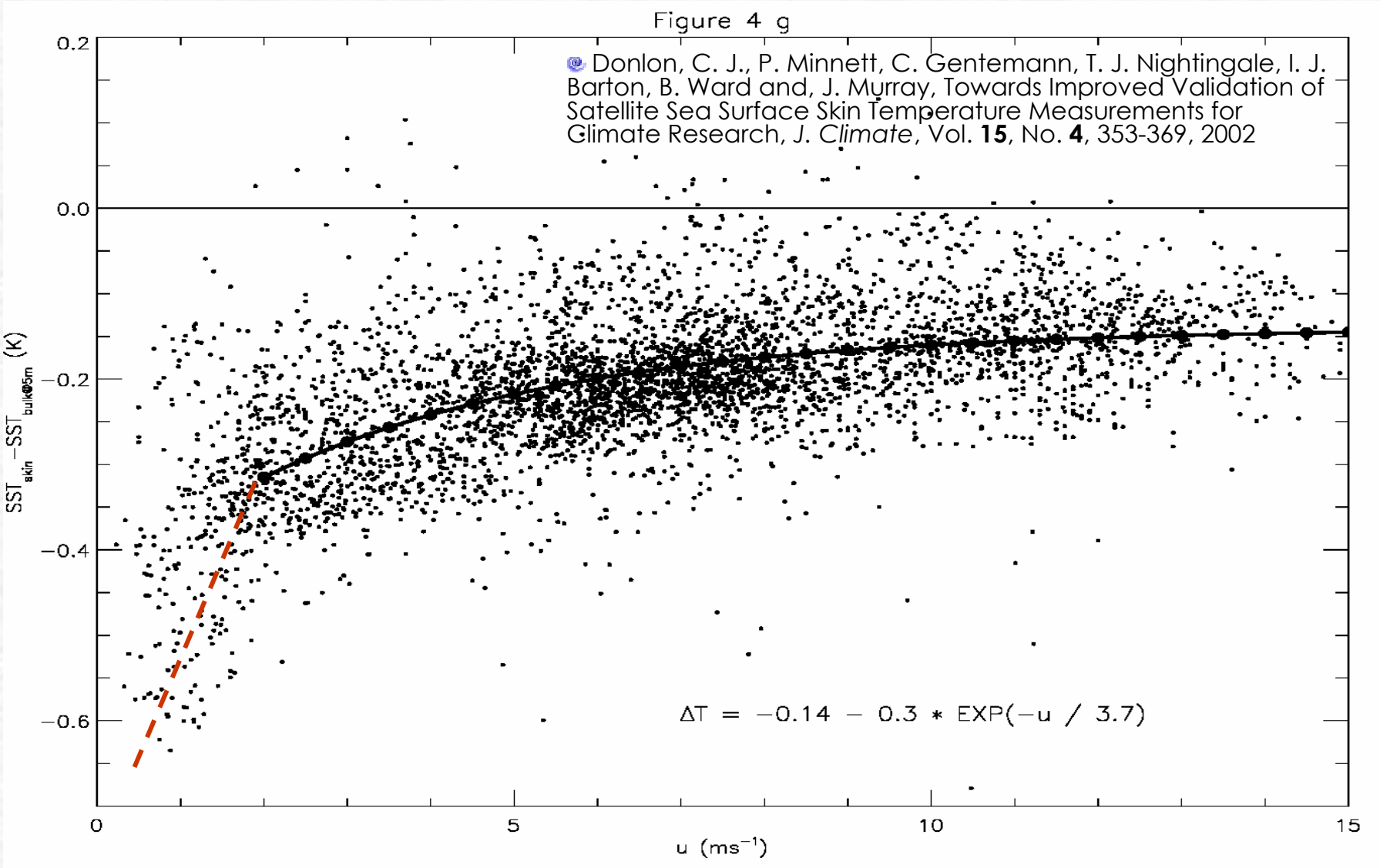
(Pinnock and Donlon et al. (2003) *in prep*)

ISDI-Data processing model: Making pragmatic sense of it all

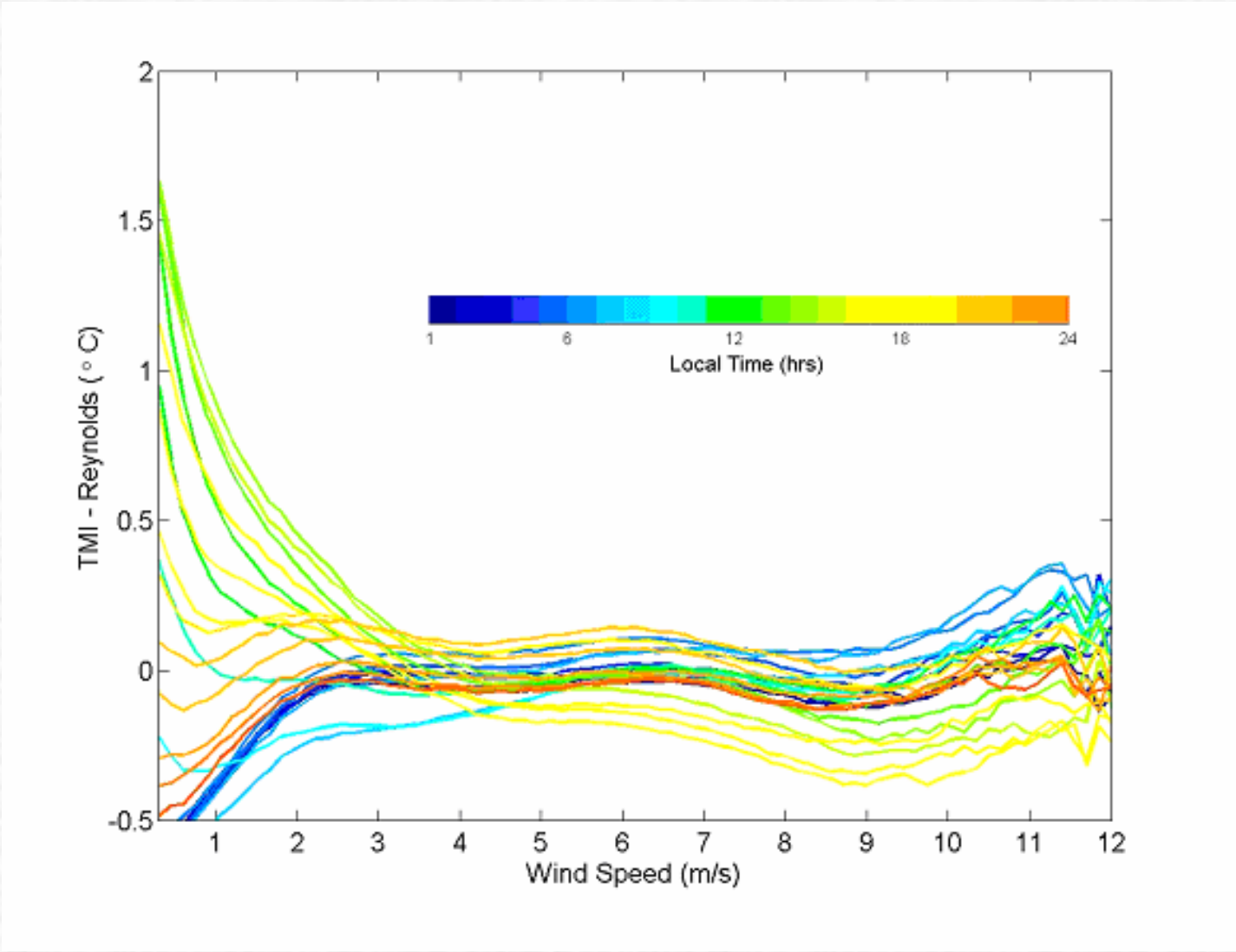
SST definitions and data products within the GHRSST-PP



Resolving SST_{skin} & SST_{depth} Differences

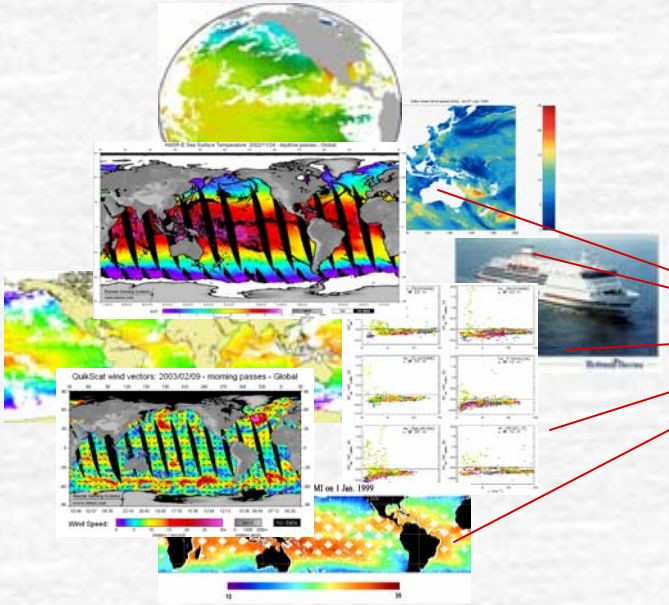


TMI diurnal Cycle: global mean

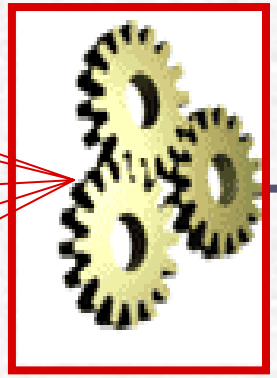


The ISDI-PM

- Pre processing and Quality control of input L2 data streams (L2P)
- Collation of single source data streams (L2C)
- Merging of L2P to merged data products (L2M)
- Analysis of L2M data (A and DV)



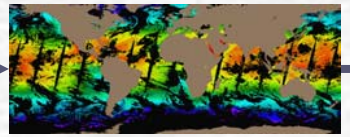
Quality Control



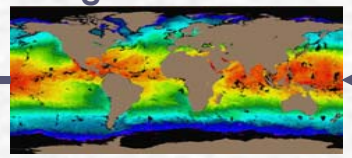
Pre-Processing

L2P

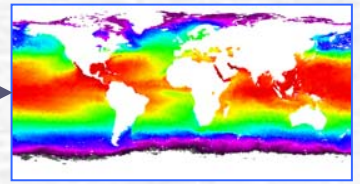
Collated and quality controlled single source L2C



Multiple source QC'd Merged L2M Stream



Analysed L3 SST data products (A & DV)

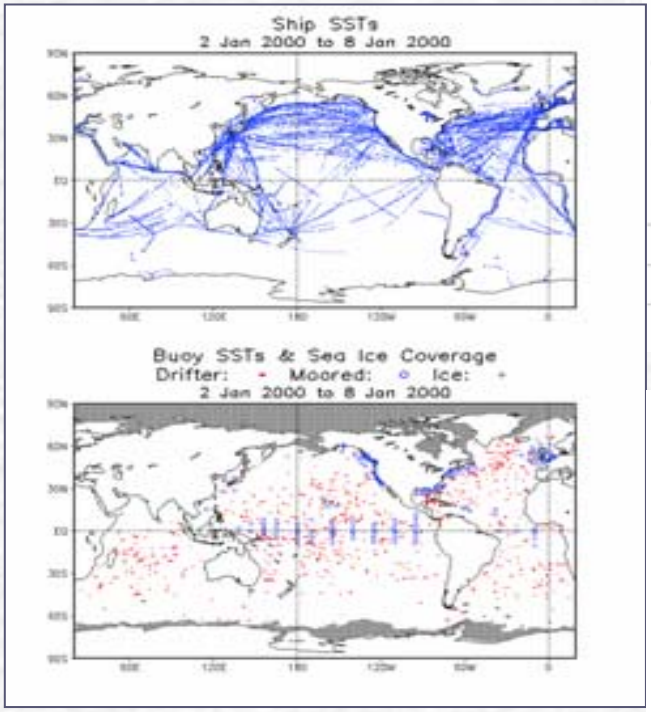


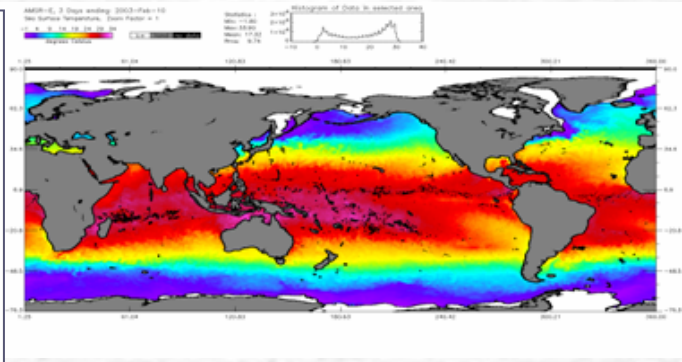
Move incomplete and inhomogeneous data

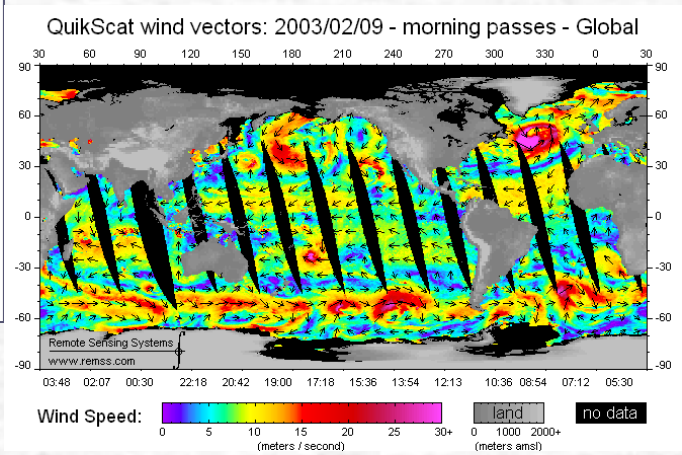
Complete, homogeneous QC data and applications

…A game of buckets and satellites…

1. Conductive Metal bucket (circa. 1950)
2. Modern dual insulated bucket
3. Canvas bucket (circa. 1900)



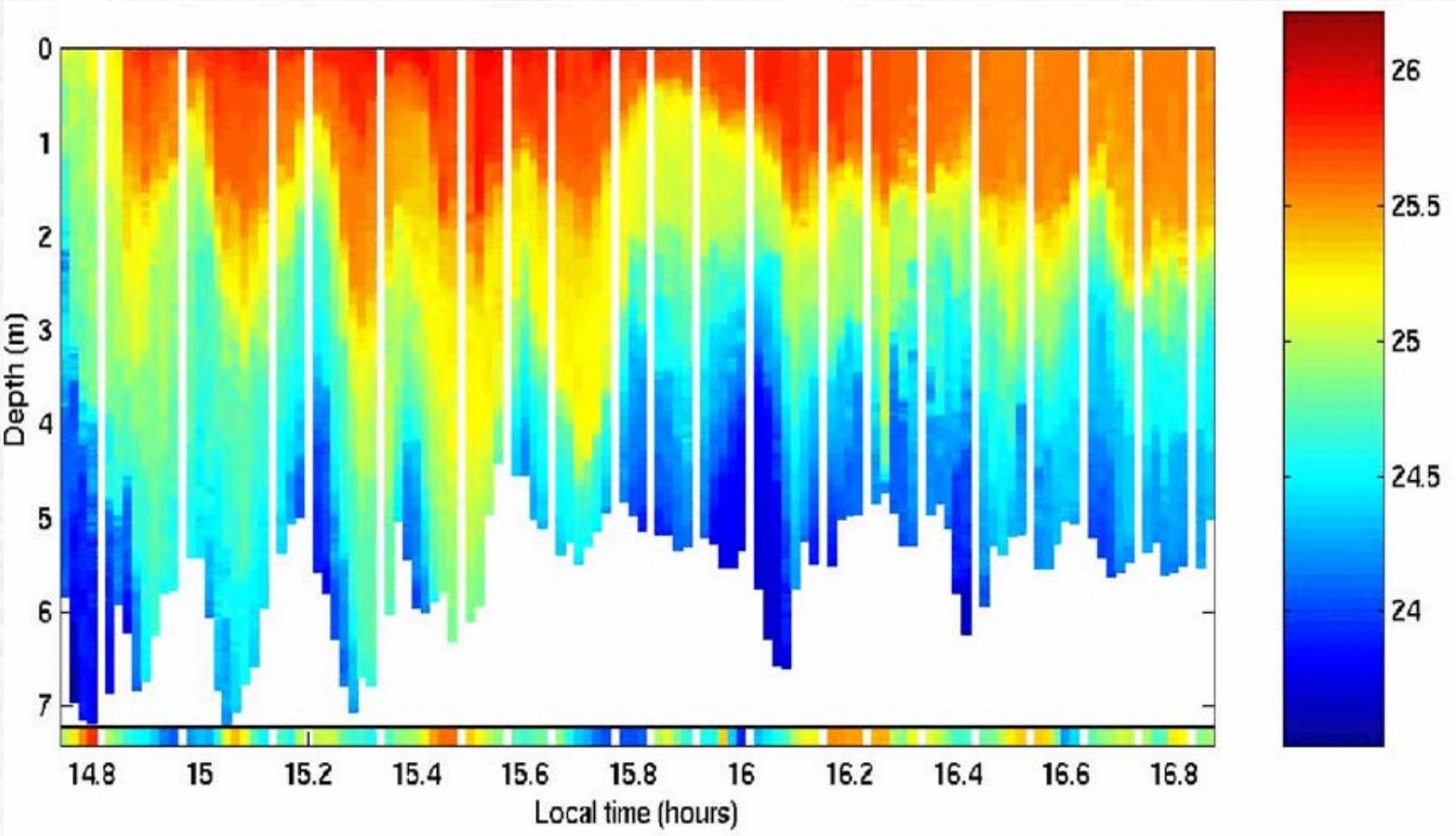




Played by an international Science Team (referee)…
and partner organisations (Players).

GHRSST-PP

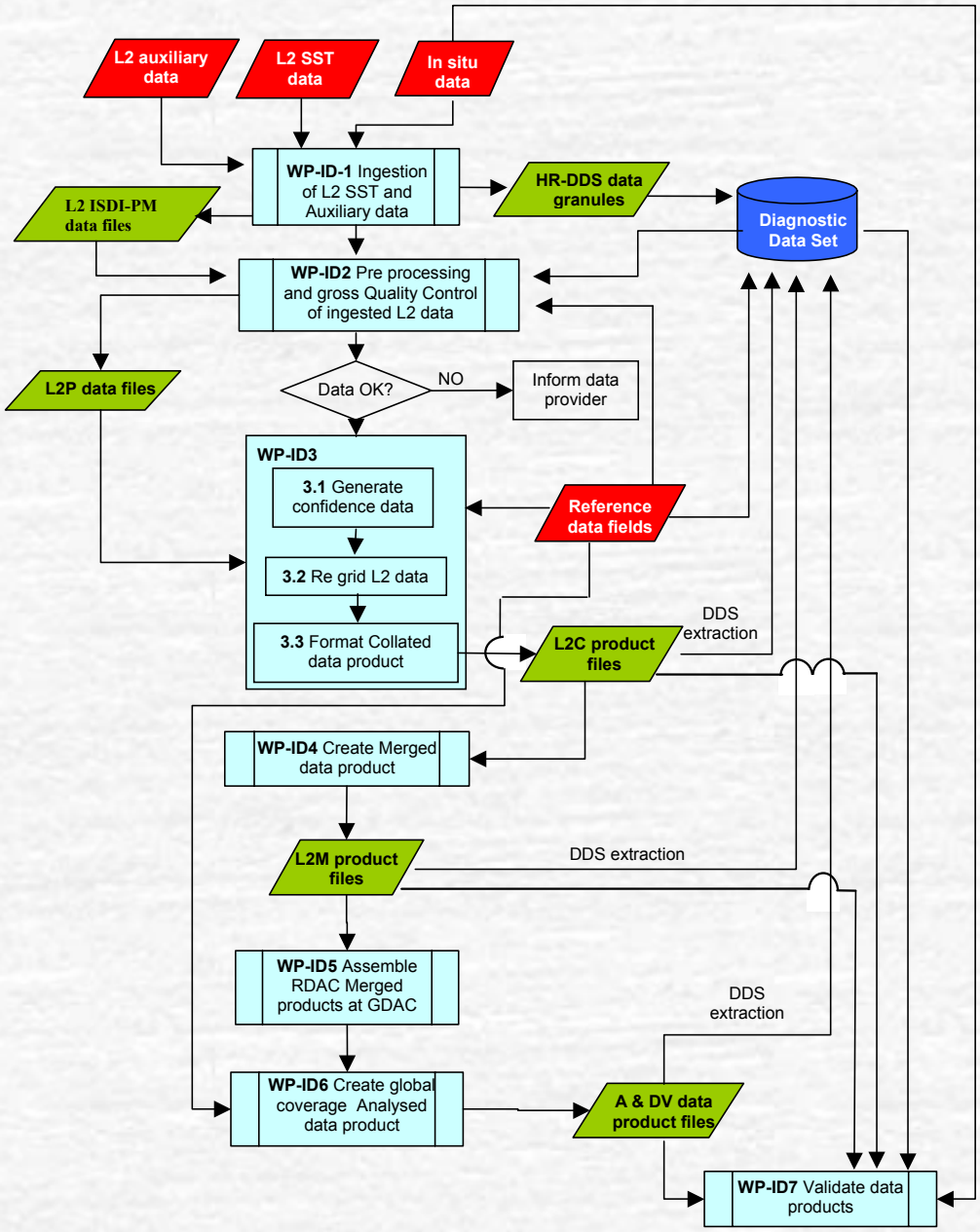
Time evolution of near-surface thermal gradients



SkinDeEP profiles on 12 October 1999. Off Baja California, R/V *Melville*.

From Ward, B. and P. J. Minnett, 2001. An autonomous profiler for near surface temperature measurements. *Gas Transfer at Water Surfaces.* M. A. Donelan, W.M. Drennan, E.S. Saltzmann and R. Wanninkhof (Eds.) *American Geophysical Union Monograph 127.* 167 - 172.

ISDI-PMv1 Overview

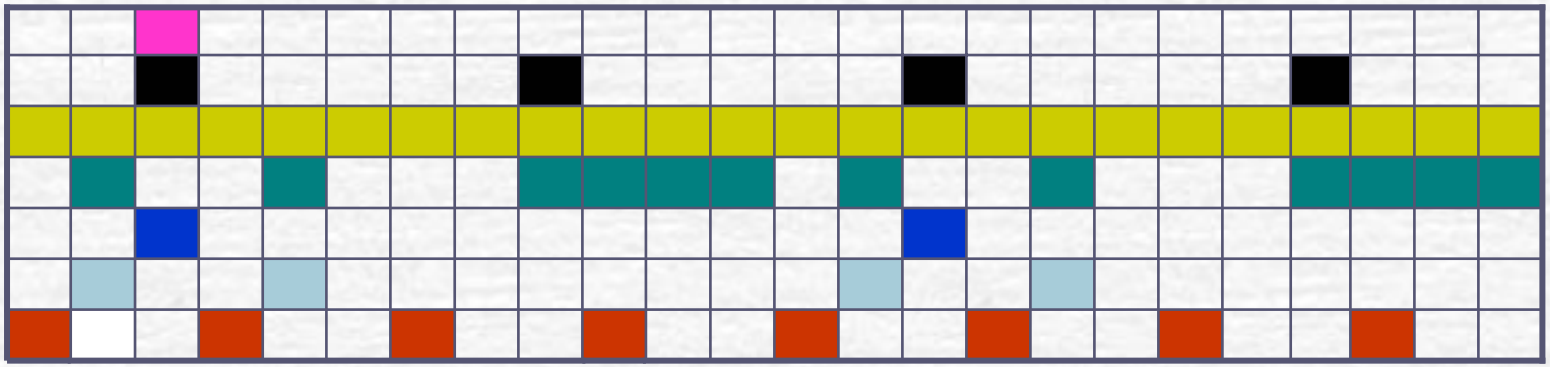


- 7 major processing steps
- **L2 data Ingestion**
  - In situ, satellite, reference data
- **L2 Pre-processing (L2P)**
  - QC at L2 pixel level, preservation of error statistics
- **L2 Collation (L2C, 6 hourly)**
  - Re-gridding of L2 data, generation of grid error and confidence data
- **Merging of collated data (L2M)**
  - Selection of highest quality Collated data
  - Output 6 hourly
- **Global assembly**
  - Transfer of regional data to GDAC
- **Analysis of merged data (A)**
  - Generation of daily SSTfnd and DV products
- **Validation of all data**

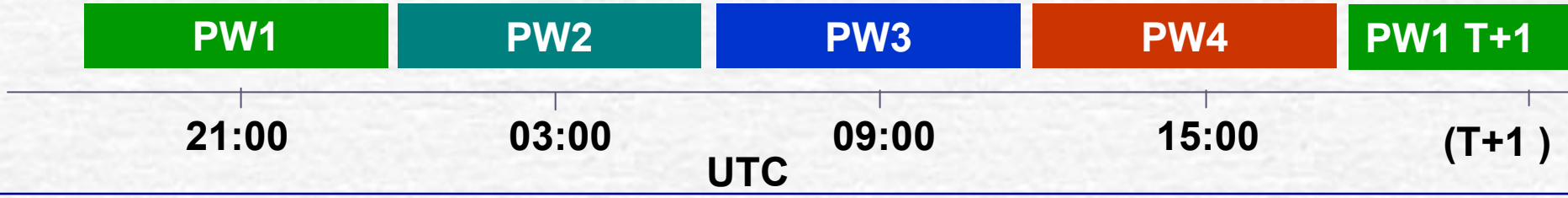
GHRSST-PP

GHRSST-PP Processing Windows (PW)

- Geostationary SSI and SST (SEVIRI, GMS, GOES-E, GOES-W)
- Microwave SSTsub-skin (AMSR, AMSR-E, TMI)
- Infrared SST (AATSR, AVHRR-N16&N17, MODIS-T, MODIS-A)
- Wind speed (AMSR, AMSR-E, SSM/I, Quickscat)
- In situ SSTdepth (Moorings, ships, drifters)
- GHRSST-PP Collated& merged products
- GHRSST-PP SSTfnd and diurnal variation data products



Analysed Product Processing Window (APPW)



GHRSST-PP

GHRSST-PP SST Data Products

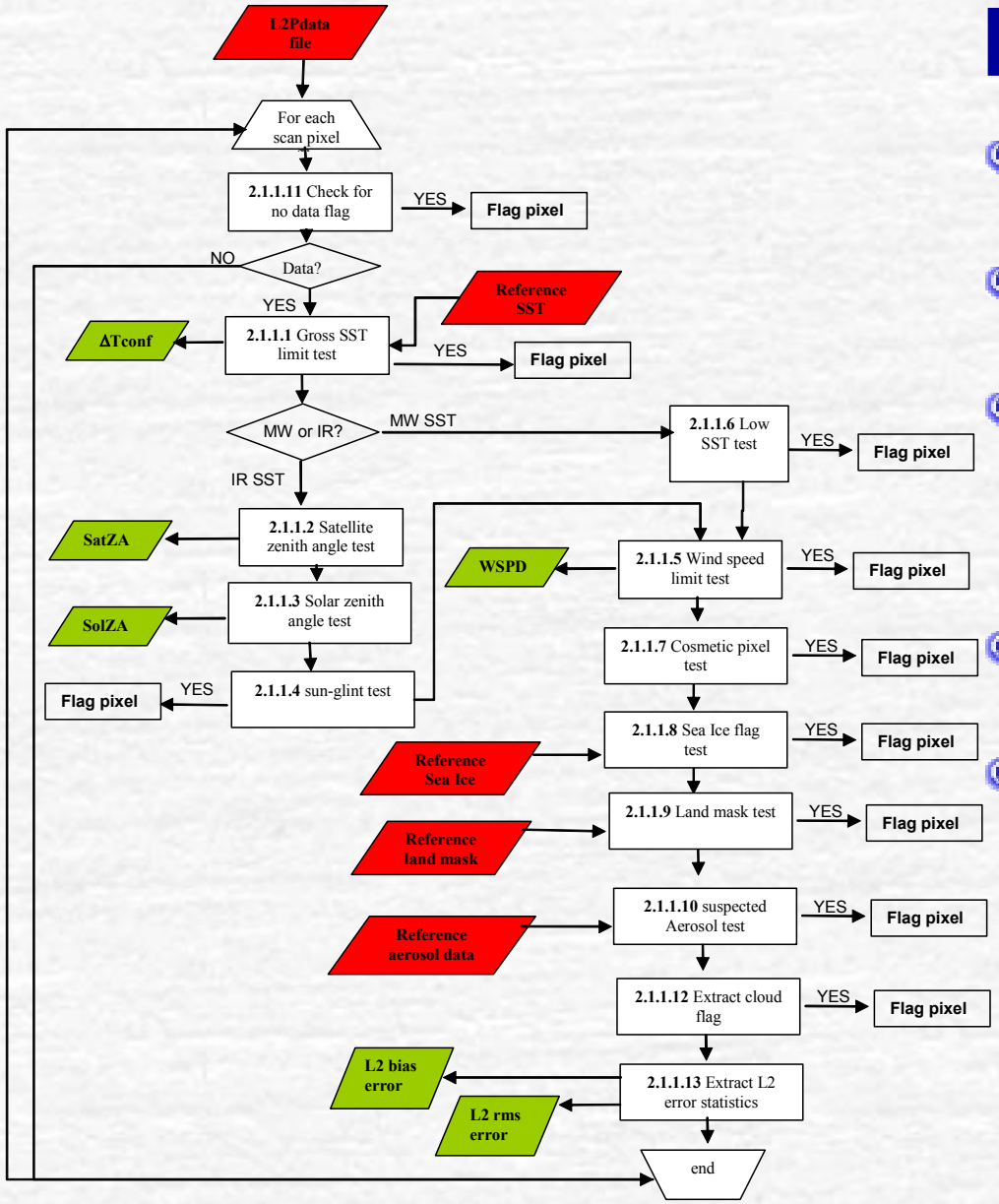
Characteristic	Collated SST	Merged SST	Analysed SST
Grid specification	1/12° 9.28 km (or 0.1°??) Equal area finally mapped to cyl. Equidistant	1/12° 9.28 km (or 0.1°??) Equal area finally mapped to cyl. Equidistant	1/12° 9.28 km (or 0.1°??) Equal area finally mapped to cyl. Equidistant
Temporal resolution	Native to data stream	6 hours (4 processing windows centred at: 00:00, 06:00, 12:00 and 18:00 UTC)	24 hours (00:00 UTC)
Delivery timescale	As available	Within 3 hours of a given processing window	Within 12 hours of an Analysed product processing window (APPW)
Target accuracy	Native to data stream, verified by QC procedures	< 0.5 K absolute 0.1 K relative	< 0.4 K absolute) 0.1 K relative
Error statistics	rms. and bias for each data stream at every grid point	rms. and bias for each input data stream at every grid point	rms. and bias for each output grid point (no input data statistics are retained)
Coverage	Regional and global as available	Regional and Global	Global , Regional extracted
SSTskin (IR) product	N/A	Yes	No
SSTsub-skin (MW) product	N/A	Yes	No
SSTfnd product	No	No	Yes
Confidence data	Yes	Yes	Yes
Diurnal variation product	Diurnal signal information within Confidence data	Diurnal signal information within Confidence data	Yes
Nominal data format	GHRSST-PP netCDF, GRIB	Hdf, GRIB, NetCDF	Hdf, GRIB, NetCDF

Auxiliary data products

Characteristic	Collated (6 hourly)	Merged (6 hourly)
Surface Wind speed (u)	Yes	Yes
Surface Solar Irradiance (SSI)	Yes	Yes
Drifting buoy SST1m	Yes	Yes
Moored buoy SST1m	Yes	Yes
Ship SST5m	Yes	Yes
ARGO SST10m or SST5m ??	Yes	Yes

All products are generated by a GHRSST-PP distributed processing system according to the rules laid out in the In situ and Satellite Data Integration Processing Model v1 (ISDI-PMv1)

L2P data products



- An exercise in pixel by pixel quality control
- Formats each L2 data stream as a GHRSST-PP L2P file
- Derives a set of L2P confidence data that is used to generate L2 Collated (L2C) data products
- Common confidence data is the key to GHRSST-PP success
- Most of the “work” is done at this stage of data processing.

Errors(1/2): L2P Proximity Confidence data

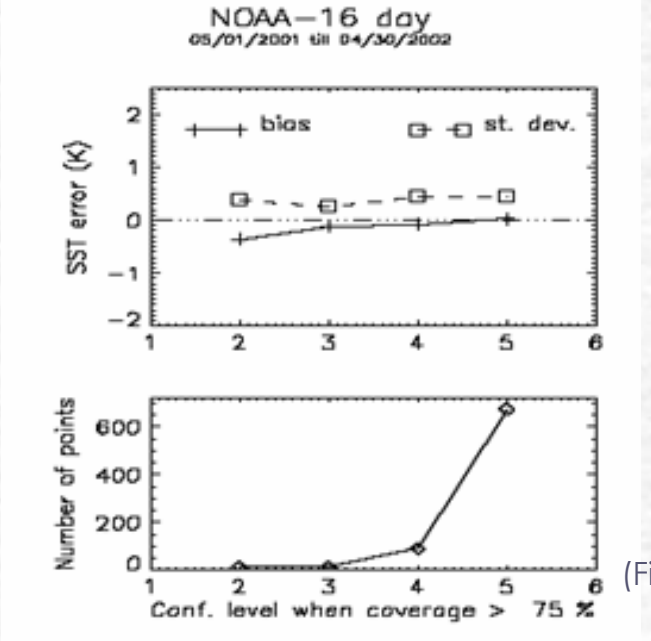
ΔTconfmin, (K)				
ΔT0			6 (Warm layer)	
ΔTconfmin	3 (Acceptable)		5 (Excellent)	
ΔT2		2 (Bad)		
ΔT3			4 (Good)	
ΔT4		1 (Cloudy)	7 (Cool skin or upwelling)	
	D1	D2	>D2	D, Distance from cloudy pixel (km)

Confidence Value	Description
0	Unprocessed: Data that have not been classified
1	Cloudy: Data that that are most probably contaminated by cloud
2	Bad: Data that are probably contaminated by cloud
3	Good: Data that may be contaminated by cloud or influenced by a cool skin effect (expect clear skies and low wind speeds here)
4	Acceptable: Data that are reasonably distant from cloudy areas and in good agreement with the expected reference SST threshold
5	Excellent: Data that are far from any cloudy areas and in good agreement with the expected reference SST threshold
6	Warm Layer: Data that are significantly warmer than the expected reference SST threshold and are probably influenced by significant diurnal warming.
7	Cool skin: Data are far from any clouds but significantly cooler than the expected reference SST threshold. This could be isolated cloud, upwelling or other dynamical feature o,r a strong cool skin deviation

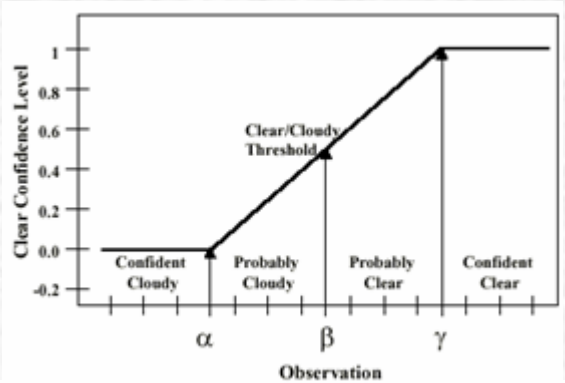
ΔTconfmin = 10 day running mean of SSTmin from Faugere et al. (2002)
D1 and D2 vary according to sensor

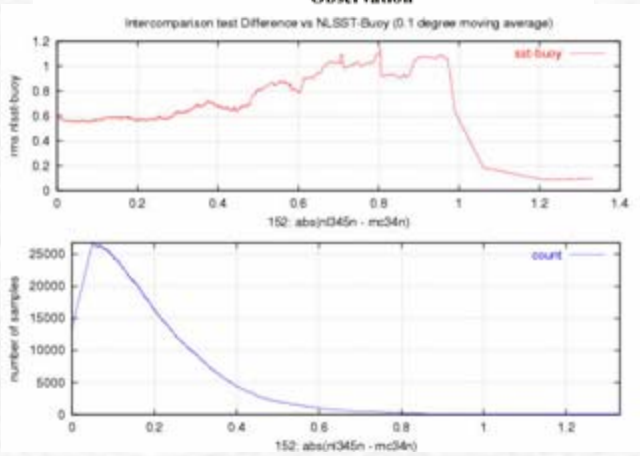
Errors (2/2): L2P Error statistics

- Error estimates based on the analysis of a large match up database (MDB) of contemporaneous satellite and in situ observations
- Based on operational schemes developed by EUMETSAT O&SI SAF and US Navy



(Figure: P. LeBorgne)





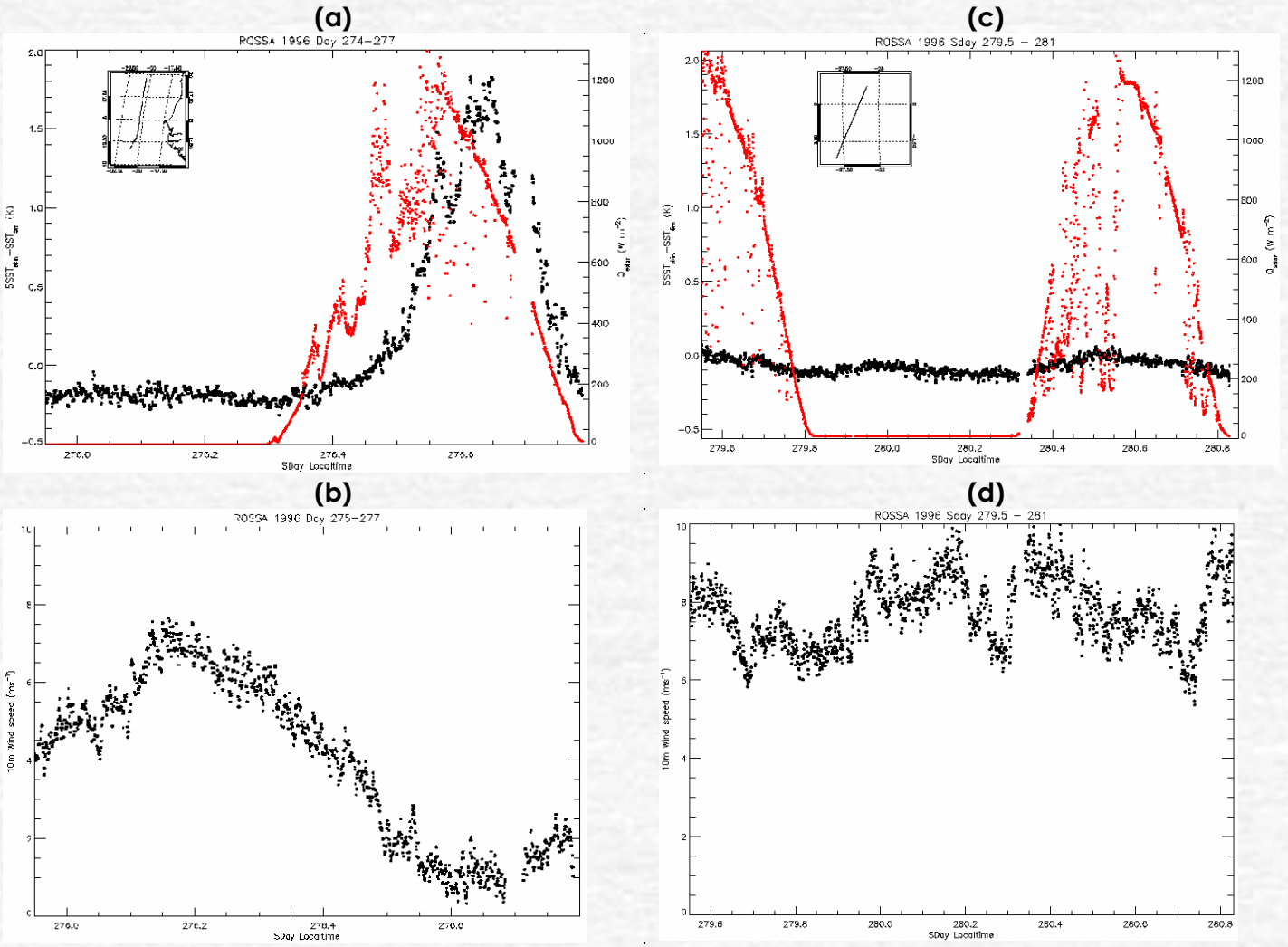
(Figures: D. May)

- Confidence is adequate for cloud flagging and most user needs
- Different approaches to be resolved

Collated data products (L2C)

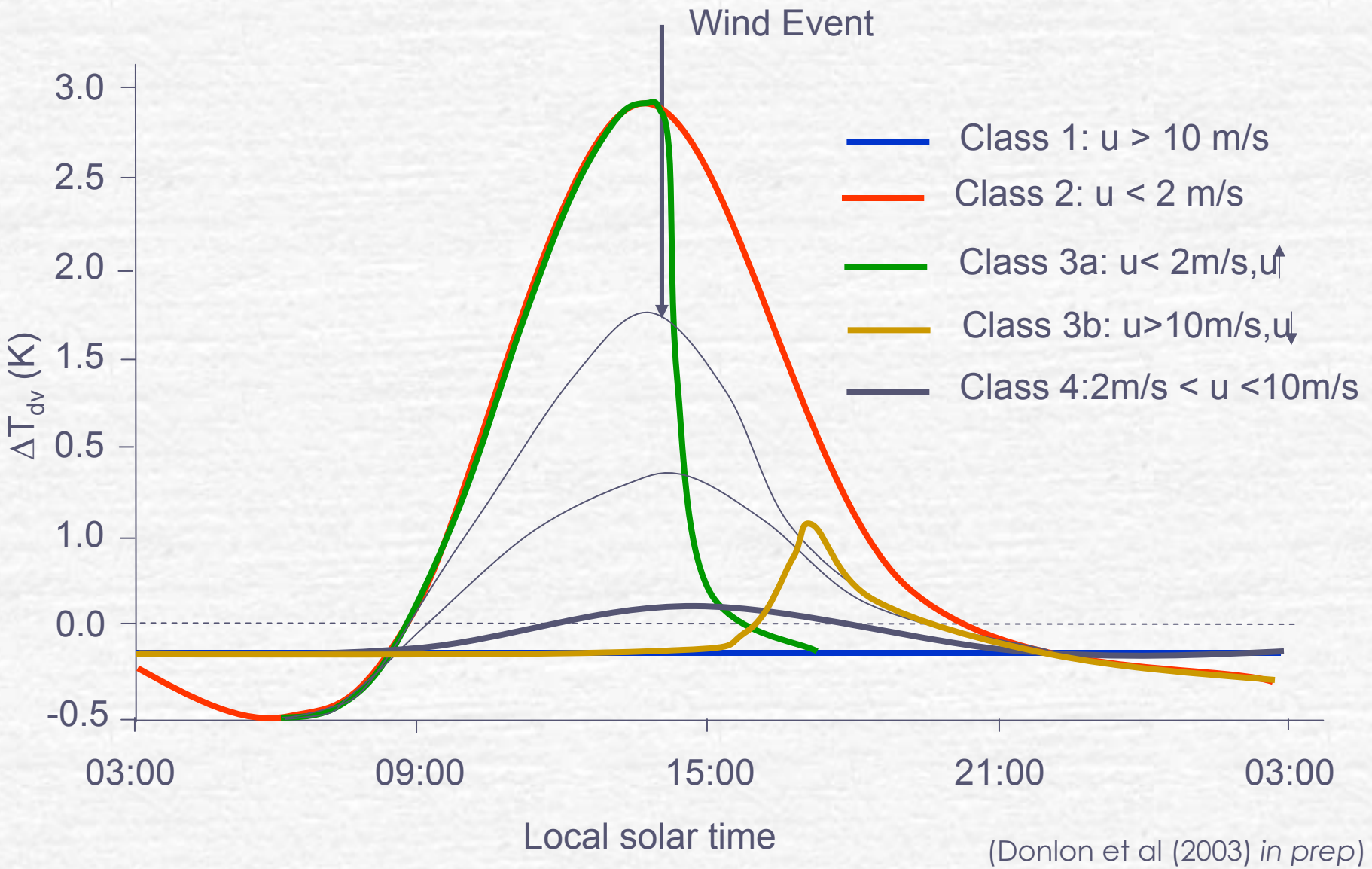
- L2C are produced for each processing window
- L2P data are used to populate a 1/12° equal-area grid:
  - Select the highest quality confidence L2P data
  - Select the closest L2P in time to the centre of a given processing window
  - Averaging of geostationary data and equal quality data
- L2C SST data products:
  - Infrared SST (SSTskin)
  - Microwave SST (SSTsub-skin)
  - in situ SST (SST1m)
- L2C auxiliary data products:
  - Wind speed (u)
  - Surface Solar Irradiance (SSI)
- Each L2C grid cell has an accompanying proximity confidence/error statistic
- Also includes a diurnal confidence data value and error statistic

Atlantic Observations: Case studies of cool skin and warm layer effects



(Donlon et al (2003) *in prep*)

Idealised classification of diurnal signals



(Donlon et al (2003) *in prep*)

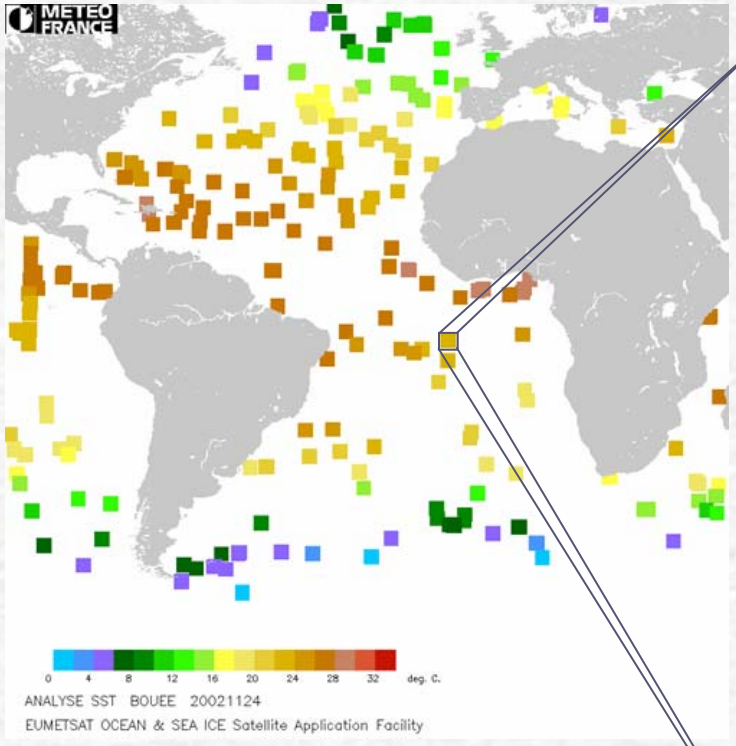
Derivation of diurnal confidence data

Wind speed threshold (ms $^{-1}$)	SSI1 (night)	SSI2 (morning/weak)	SSI3 (afternoon/strong)	Surface Solar Irradiance (SSI) (Wm^{-2})
> WS3	1 (Persistent cool skin)			
< WS2	2 (Moderate cool skin)		3 (Warming)	
< WS1		4 (Moderate warming)		
< WS0	6 (Strong Cool skin)		5 (Strong warming)	
	>D2 Far from cloudy areas		>D2 Far from cloudy areas	D (km)
	ΔT4-ΔT3	ΔT2-ΔT3	ΔT0	ΔTconf_fnd (K)

- WS1-WS3 are threshold values
- D1 and D2 are sensor specific threshold values
- ΔTconf_fnd = 10 day running mean of SSTfnd
- SSI Surface Solar Irradiance threshold values

	Confidence Value	Description
	0	**Unprocessed:** Data are not classified due to lack of information (wind speed, SSI)
Class 1	1	**Persistent cool skin:** Wind speed is sufficient to inhibit the formation of thermal stratification or significant cool skin layers. Skin effect set to -0.15 K (Donlon et al. 2002)
Class 3a/3b &4	2	**Moderate cool skin:** A small cool skin deviation is possible
	3	**Warming:** A warm layer is likely but is inhibited by wind mixing
	4	**Moderate warming:** A warm layer is probable but may be limited by wind mixing
Class 2	5	**Strong warming:** A significant warm layer is expected
	6	**Strong cool skin:** A significant cool skin deviation is expected

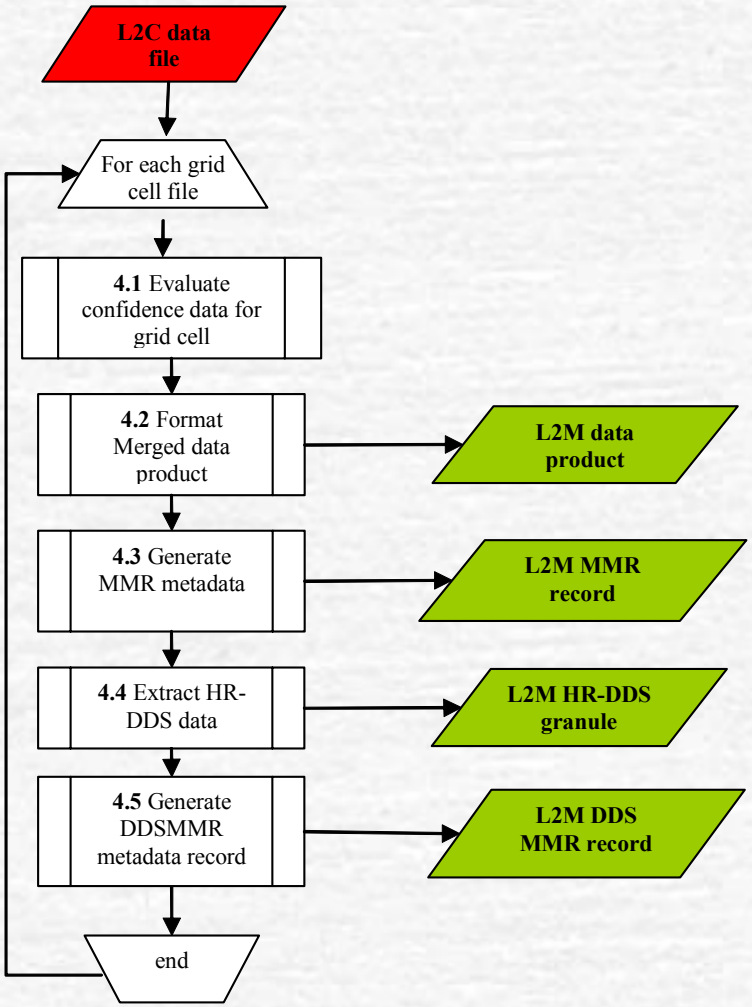
L2C data product: Example in situ



2.5 degree grid Collated BUOYS from 18 till 00 UTC used by the EUMETSAT O&SI SAF

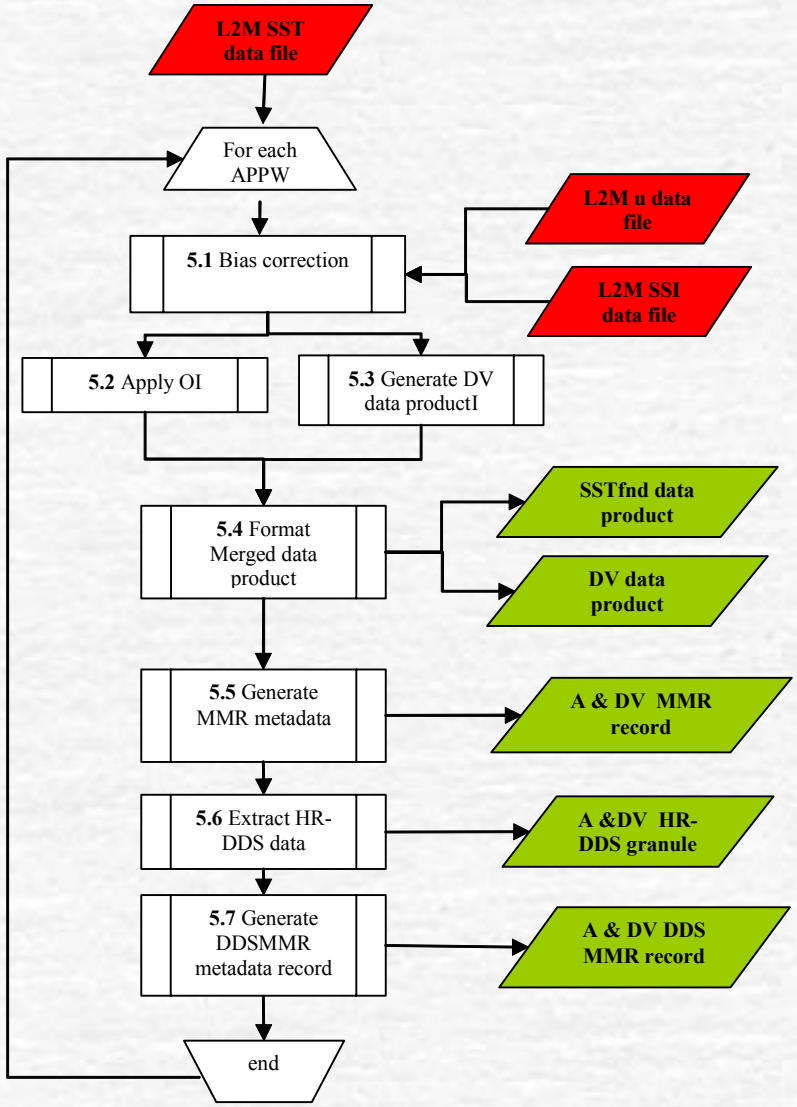
Byte position	Name	Definition	Description	Units
+1bytes	L2_source	See table 4.2.1	Satellite Code	INT
+2bytes	Time	??	Grid cell acquisition time	UTC
+2bytes	L2_native_Bias	See section5.1.1.?	Grid cell error characteristics based on L2 native confidence flags	K, SCALED INT
+2bytes	L2_native_rms	See section 5.1.1.?	Grid cell error characteristics based onL2 native confidence flags	K, SCALED INT
+2bytes	ΔT_conf	See section 5.1.1.1	Deviation form reference SST	K, Scaled INT
+2bytes	SatZA	See section 5.1.1.2	Solar zenith angle	Deg, Scaled INT
+2bytes	SolZA	See section 5.1.1.3	Satellite Zenith angle	Deg, Scaled INT
+2bytes	SSI_value	See section 5.1.1.14	Near contemporaneous SSI value	Wm^{-2}, Scaled Int
+1byte	WSPD	See section 5.1.1.5	Wind speed value	Scaled byte
+2bit	Aerosol_present	See section 5.1.1.10	Suspected atmospheric Aerosol present. 0=no aerosol, 1=native flag from L2 data stream, 3=reference data	Code
+1bit	No_L2_data	See section 5.1.1.11	No input data available	Flag
+1bit	ΔTconf_fail	See section 5.1.1.1	SST out of limits	Flag
+4bits	Land_sea_flag	See Table 5.1.1.9.1	Pixel type classification sea or land	Code
+1bit	Cloud	See section 5.1.1.12	Input data are all cloudy	Flag
+1bit	SunGlint	See section 5.1.1.4	Suspected sun glint: Glint > threshold	Flag1
+1bit	CosmeticFill	See section 5.1.1.7	Pixel is a cosmetic value	Flag
+2bir	Sealce_present	See section 5.1.1.8	Ice contamination flag 0=no sea ice, 1=sea ice flag from native L2 data stream, 3=sea ice from reference field	Code
+1bit	Coast_flag	See section 5.1.1.9	Grid cell is within a coastal area	Flag
+1bit	TMILowSST	See section 5.1.1.16	TMI SST is low	Flag
+2bits	Grid_coverage	Table 6.2.1.1	Estimated coverage of the grid cell area by input data	Coded on 4 levels.
+2bytes	Bias	Rule 6.2.3	Error characteristics based on confidence flags	K, Scaled INT
+2bytes	Rms	Rule 6.2.3	Error characteristics based on confidence flags	K, Scaled INT
+4bits	Proximity_Confidence	See section 6.3.1	Proximity confidence value	0-7
+3bits	D	See section 6.3.1	Threshold check to nearest cloud y pixel	Code of D values
+1bit	Significant_DV	See section 6.3.2	Suspected significant diurnal signal	0 or 1
+3bits	DV_confidence	See section 6.3.3	Diurnal confidence value	Code 0-7
+2bytes	DV_magnitude	See section 6.3.4	Estimated Diurnal magnitude	K, Scaled INT
+1byte	DV_shape	See section 6.3.4	Diurnal shape code	Code
+6bytes	Spare		Reserved fro ISDI-PMv2	N/A

Merged Data products (L2M)

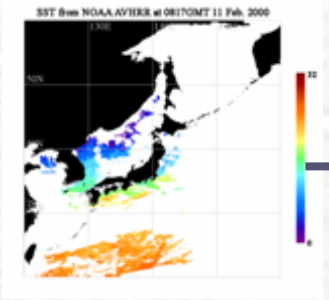


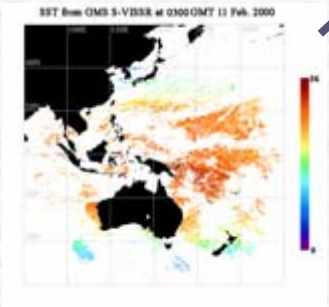
- Based on L2C data for a given PW – a selection procedure
- Rules for L2M:
  - Select the highest quality confidence L2C
  - Select the closest L2C in time to the centre of a given processing window
- Also: *a priori* selection of data by satellite sensor e.g.:
  - IR: AATSR, MODIS, AVHRR
  - GEO: SEVIRI,GOES; GOES,GMS
  - MW: AMSR | AMSR-E, TMI
  - U: AMSR | AMSR-E, TMI, SSM/I
- Work in progress

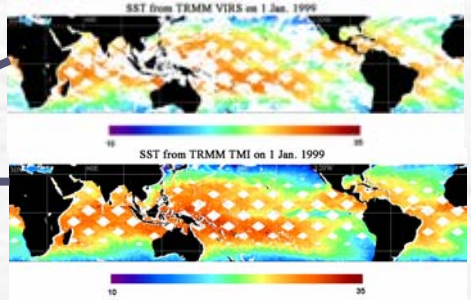
Analysed data products (A and DV)



- 'A family' products (SSTfnd): Based on the New Generation SST method developed by the U. Tohoku, Japan.
  - Bias adjustment scheme relative to "daily minimum SST"
  - Optimal interpolation
  - v2 uses Variable decorrelation length scales
  - Error statistics and confidence data for each grid cell
  - Cool skin layer effects may be accounted for using Donlon et al. (2002) parameterisation scheme.
- Diurnal Variation (DV) product based on new approach (work in progress – see later)
  - Library of DV signature shapes
  - Use u and SSI together with dT to select the most appropriate



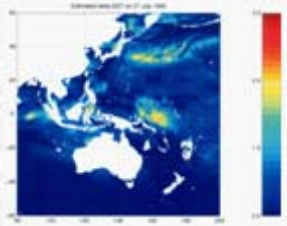


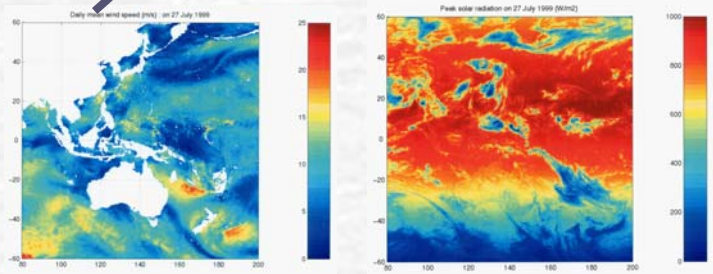


Original SST
AVHRR, VISSR,
VIRS, TMI

Diurnal Variation Correction

Solar Radiation
VISSR
Wind Speed
QSCAR, TMI, SSMI





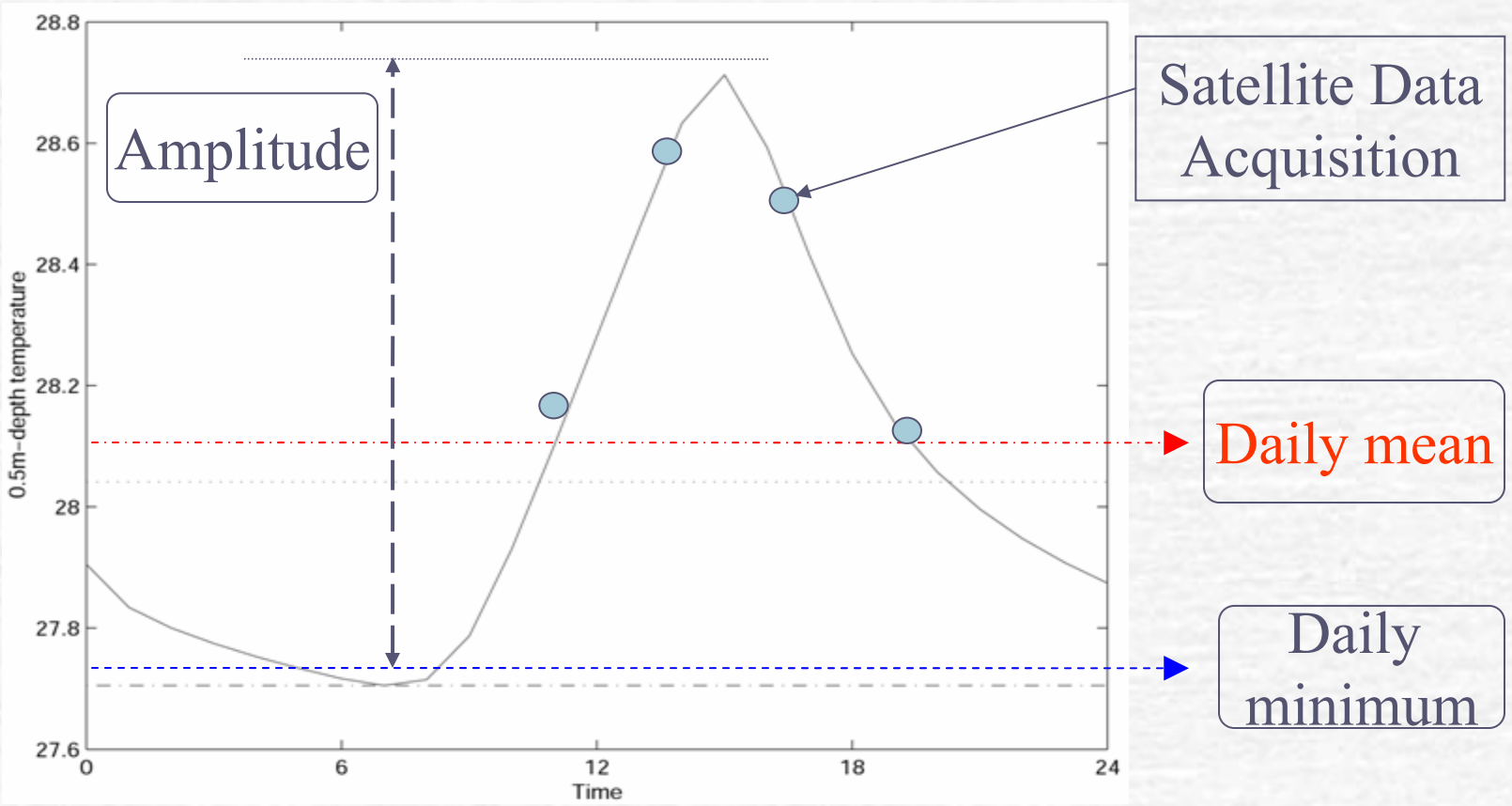
Daily Min. SST
AVHRR, VISSR,
VIRS, TMI

Objective Analysis

Merged SST

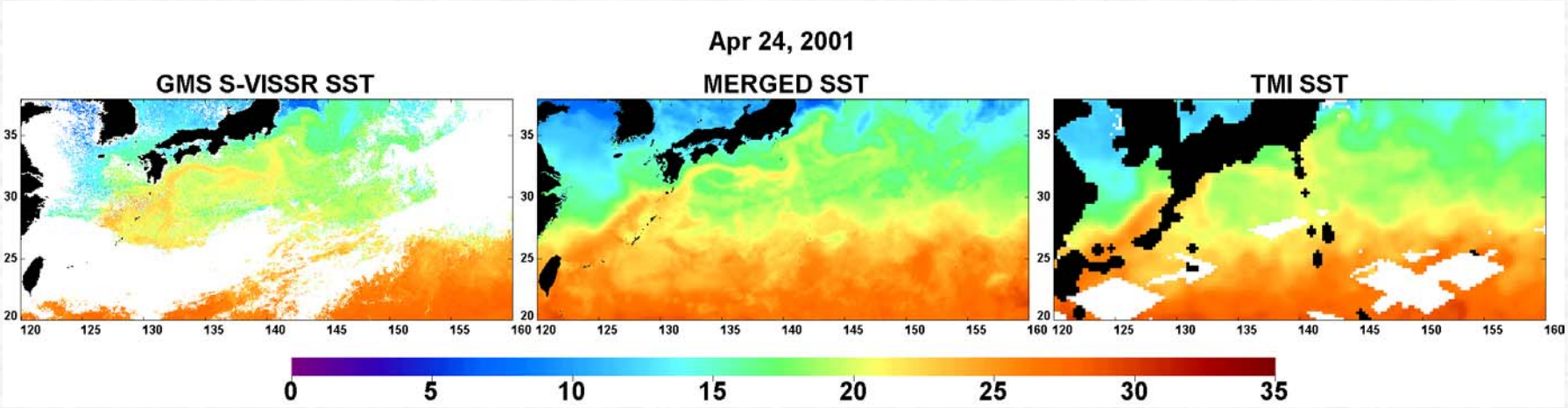
SST Merging Flow for the New Generation SST Ver 1.0

NGSSTv1 bias correction scheme



- Simulate SST diurnal variations by the one-dimensional surface-layer model (Kawai and Kawamura, 2000)
- Shift a satellite-derived SST to a daily standard value by a regression formula

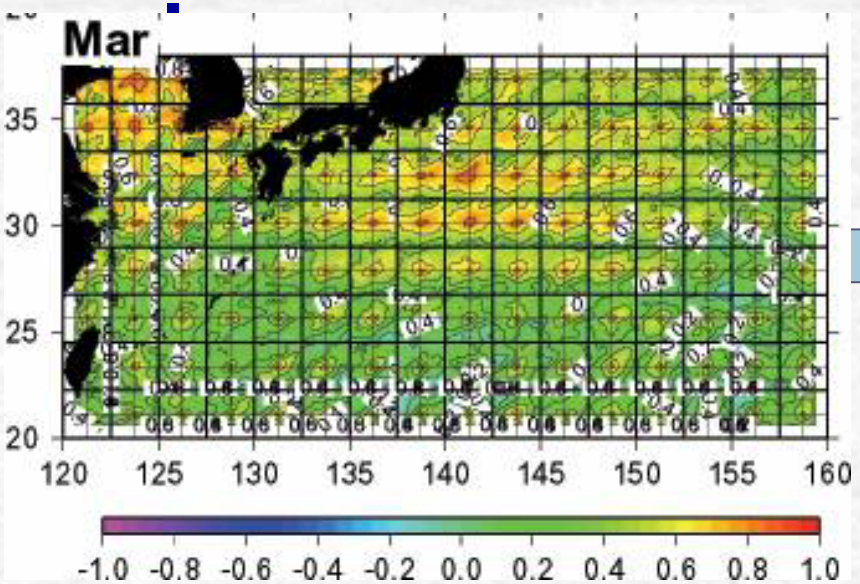
New Generation Sea Surface Temperature v1.0: example



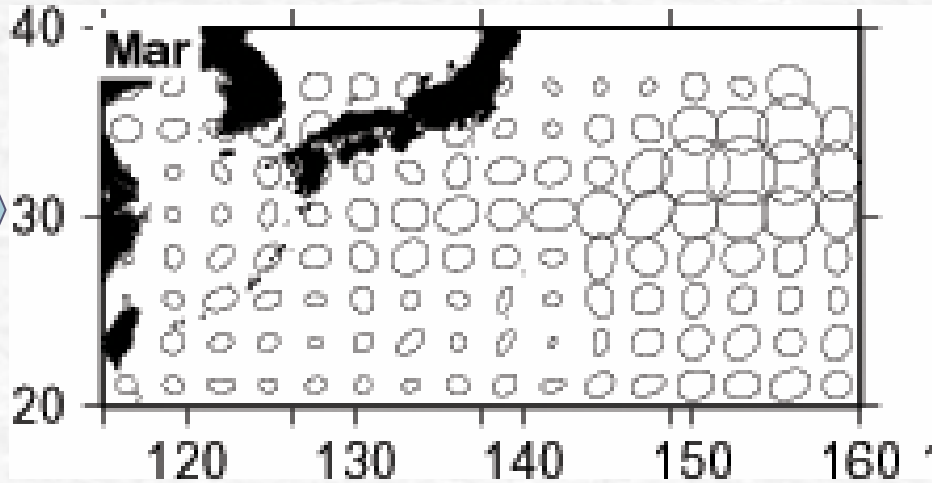
High-resolution Cloud-free Daily SST Products

5-km spatial and 24-hour temporal resolution

NGSSTv2: Monthly regional decorrelation



Correlation matrix for March



Decorrelation scale for March

- Since Tokyo workshop, NGSST-v1 has been extended
- Decorrelation scale, e-folding scale of SST variability for each month and region
- Spatial O (2-3 degree) and temporal order (2-3 day); strongly inhomogeneous, anisotropic and time-dependent (Note NGSSTv1 used fixed scales of 100km, 3day)
- Scales are mainly defined by atmospheric variability

Status of regional projects and funding

Overall Status of GHRSST-PP

- Planning and organisation is accelerating: GHRSST-PP is maturing nicely.
- International agreement has been reached on the Processing model and a technical document is in prep.
- Considerable resources have been made available by JPL PO.DAAC (computing facilities and data.access/archive) for implementation of the UIS and a GDAC facility.
- Users are beginning to refer to the GHRSST-PP as a source of SST data for future projects.
- Data management plans are now maturing.
- Technical challenges of data exchange are not properly addressed yet.
- Project Office to coordinate GHRSST-PP is timely

Key Regional Project Developments

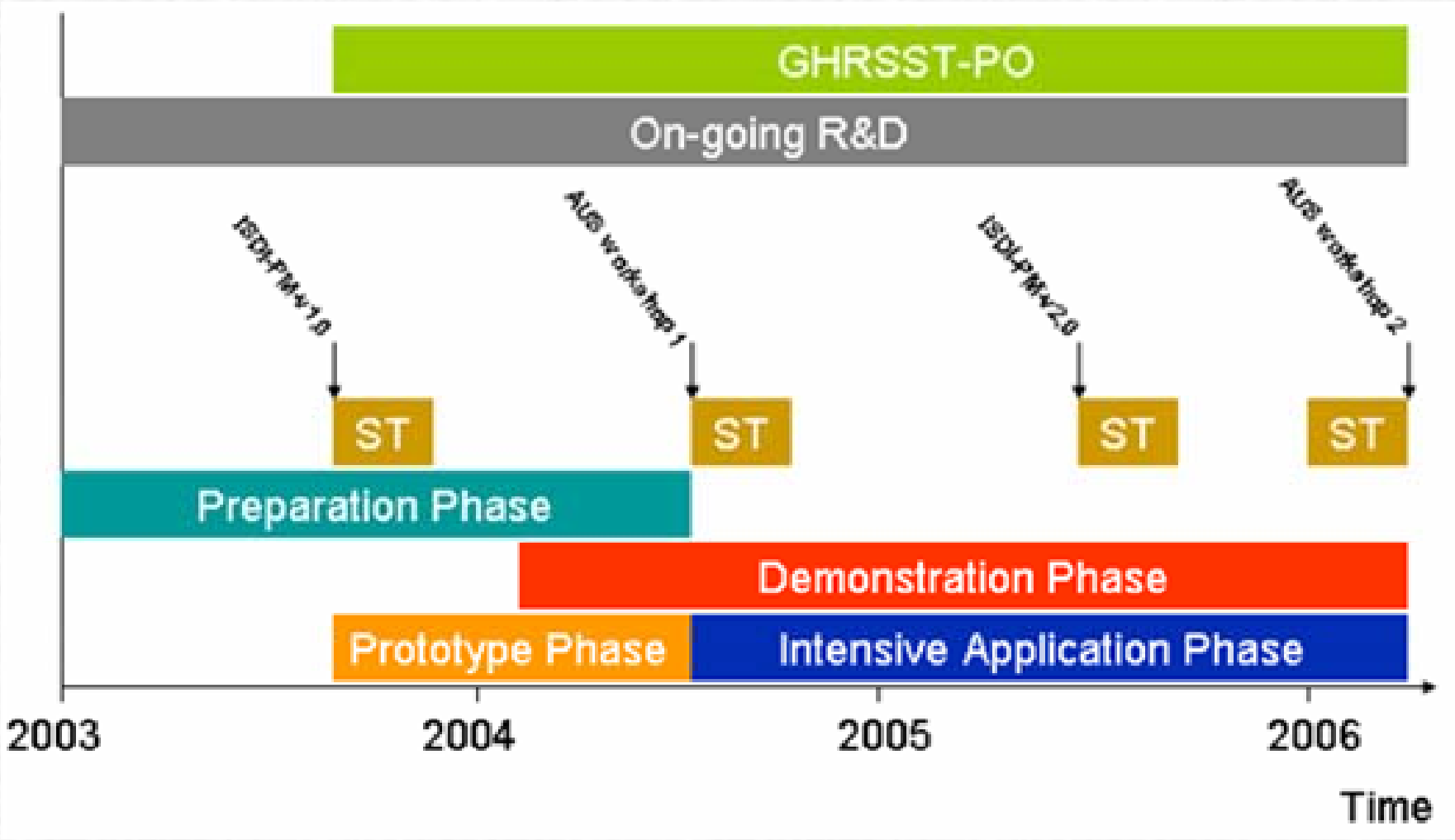
- **Japan:**
  - GHRSST-PP AMSR data server (next week?)
  - Development of NGSST-v2 to be adopted by GHRSST-PP (March)
  - User community developing well. E.g., experimental collaboration with JMA for operational users
- Status excellent:developing activities and new funding
- **Europe:**
  - Project coordination is *ad hoc* currently based at the European Commission. A GHRSST-PP International Project Office will open in Sept 2003 based at the UK Met Office, funded by ESA and the Met Office.
  - EU RDAC Medspiration project in preparation (1MEuro, Start Dec 2003) DRD accepted, DPM in prep. Need the GHRSST-PP ISDI-PMv1 first!!
  - ESA GHRST-PP AATSR data server (March?)
  - HR-DDS pilot complete at JRC.
  - User community developing rapidly with several projects planning to use GHRSST-PP products (e.g., MERSEA-IP, ECMWF, Met Office, Mercator).
- Status good: developing activities and new funding

Key Regional Project Developments

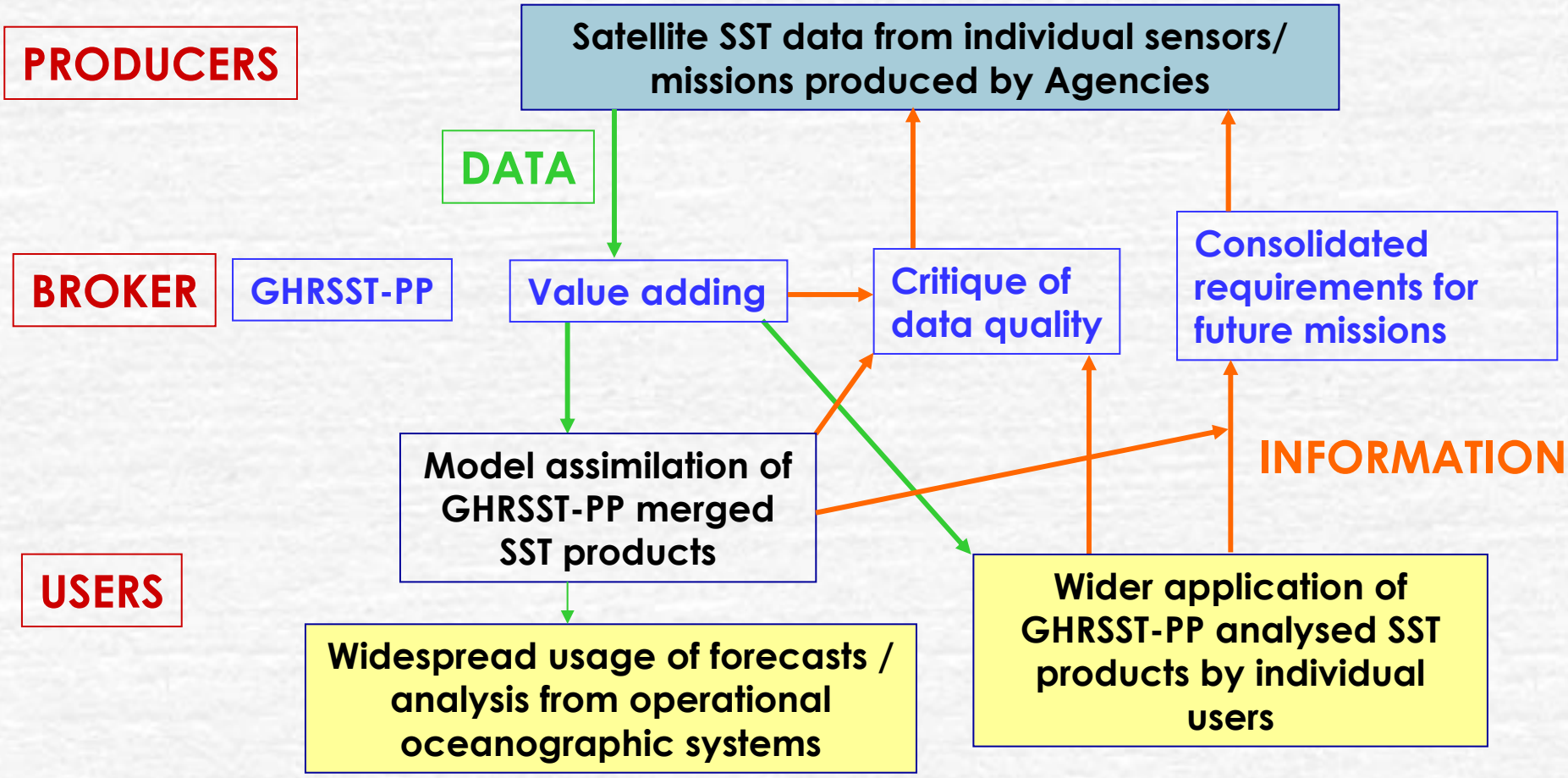
- **USA:**
  - RDAC project proposal in preparation (NASA REASoN)
  - In situ validation activities planned as part of a NOPP proposal ($0.5M)
  - Establish GDAC and MMR at JPL PO.DAAC
  - REMSS delivery of TMI/AMSR/SSM/I data streams via www
  - User community developing slowly. Users are often the producers...
  - UIS components in discussion after 3rd Workshop
  - JPL to host 4th GHRSST-PP workshop in late 2003 (Sept/Oct)
- Status good: developing but fractionated

Conclusions

GHRSST-PP Implementation Schedule



Conclusions: A view of the role of the GHRSST -PP



The end